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The Geographical Journal

Vol. LXVII No. 4 April 1926

THE ASSAM–BURMA FRONTIER

J. P. Mills, I.C.S.

Read at the Meeting of the Society, 11 January 1926.

I GREATLY appreciate the honour which the Royal Geographical Society has done me in asking me to lecture on the Assam–Burma frontier. Would that my qualifications were greater! All the knowledge I can boast is that picked up during some years of very busy service in that corner of our Indian Empire. In describing the country which I know I shall not confine myself to its physical features, but shall say something of the little-known tribes inhabiting it. In doing so I feel I have ancient and excellent authority behind me, for the early geographers never failed, when writing of strange mountains and deserts, to say something of the even stranger races to be found there. Indeed, it is in these very hills of Eastern India that some of these queer folk are placed. One night in 1922, sitting by a camp fire, I was told by a Naga of a tradition of a tribe whose ears were so long that when they went to bed one served as a mattress and the other as a blanket. Dr. Hutton has pointed out to me that Pliny had not only heard and recorded this story nearly sixteen hundred years before I did, but that he also places *in quadam convalle Imai* (*e.g.* Himalaya) *montis*, a tribe of cannibals which he calls *Abarimon*, which is simply the Assamese words *abāri manuh* (" independent men "), a term commonly used to this day for any wild hill tribe. This proves the interesting fact that Pliny must have used an Assamese source, and makes one realize how far stories travelled in ancient times, and how long-lived they are, even when false. The inhabitants of these hills are of particular importance, as their methods of agriculture seem to be causing no small alteration in the geographical features of the country.

A glance at the map will show what a curious position Assam occupies, tucked away in the far north-east corner of India proper. It is itself a great alluvial plain, only 300 feet above sea-level, though it is 600 miles from the mouth of the Brahmaputra, which waters it. It is united in the south with the alluvial plain of Bengal. Its inhabitants are closely allied to those of Bengal. But almost surrounding it are great mountain ranges inhabited by people of Mongolian stock. To the north and east of it are the Himalayas, rising almost sheer up to enormous heights, and to the south-east a long range of mountains stretches for 500 miles

down towards the Bay of Bengal, continuing as a raised line under the sea till it reappears as the Andamans and Nicobars, and passes through Sumatra and Java and beyond, forming one of the longest ranges on the Earth's surface. For much of its length this range forms the boundary between Assam and Burma. Very little has been written on this frontier, and most of what has been recorded is hidden away in obscure journals. About 1825 a pretender to the throne of Assam prevailed upon the King of Burma to send an army to assist him. It marched through the Naga hills, it is uncertain by what route, committing horrible atrocities on the way, and spread terror and destruction throughout Assam. We sent troops which turned the Burmese out, and ourselves took over Assam. Then followed a series of reports, mostly based on hearsay, on routes through the hills. But this temporary interest died down when the annexation of Upper Burma put an end to all further fear of an invasion from that side. It is one of the most curious frontiers in the world, and a great natural boundary. On the west lies the valley of Assam, and on the east the valleys of Chindwin and Irrawady. Yet, though it lies between two fertile, populous provinces, with their railways, roads, and steamer services, it is as yet largely unexplored and contains some of the most primitive tribes to be found within our Indian Empire. In the northern portion it has been crossed only in a few places. Sadiya, in the north-east of Assam, has been reached from Burma more than once, but with great difficulty. There is a way through the Hukong valley which has been surveyed with a view to building a railway at some future date. The route from Burma would be up the Hukong, over a divide at about 3000 feet, I think, and down the Dihing to Margherita, where the line would link up with the Assam–Bengal Railway. At present, if a traveller wishes to go from Dibrugash, say, to Myitkina, in Upper Burma, about 200 miles away as the crow flies, he has to go by train to Calcutta, where he takes a boat to Rangoon, from which he begins another enormous railway journey. South of the Hukong valley no white man has been through till we get down to the level of Kohima, the headquarters of the Naga Hills district. Up to Kohima there is a metalled road from the plains of Assam. From there there is a bridle path which reaches almost to the Burmese boundary, some way south of Saramatti. It is possible to get through from there, and every two or three years the Deputy Commissioner of the Naga Hills, and the Deputy Commissioner of the Upper Chindwin meet and discuss various local matters which require settlement. From Kohima too it is quite easy to get through Manipur State to the Chindwin valley. Further south there are several ways through.

It will thus be seen that the least penetrated, and so the least known, portion of the frontier is that between the Hukong valley and the southern end of the Naga Hills district. It is here that I served, and it is with this little-known country that I have to deal. The Naga Hills district

is a long strip of hill country bordering the plains of Upper Assam. It was taken over in order to protect the plains from raids by head-hunters. To the east of this strip is a block of independent territory inhabited by wild tribes, between the Assam and the Burma administrative boundaries. It is this which forms the barrier.

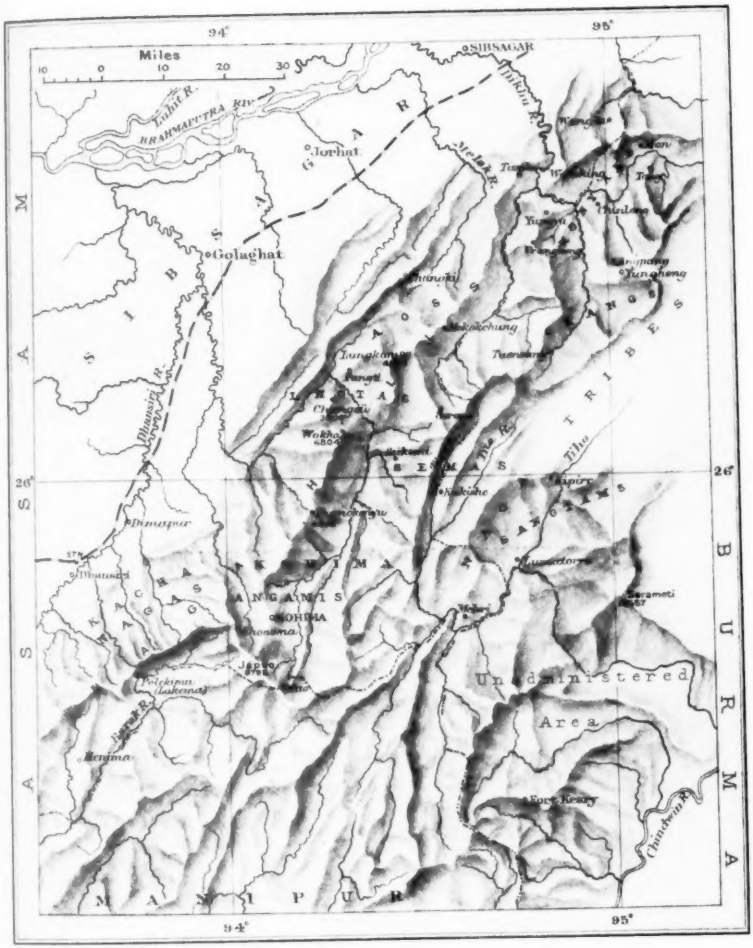
Of course a column *could* get through anywhere, but tribes with whom we have never been in touch would probably oppose us, more through ignorance and panic than for any other reason, and to use modern rifles against bows and spears would mean not only loss of life, but the loss of all hope of establishing friendly relations for years to come. This has never been our way. Instead, we sit in the administered area, a Deputy Commissioner at Kohima and a Subdivisional officer at Mokokchung (some 86 miles away) with a battalion of Gurkhas for use if need be, and slowly work to gain the confidence of the tribes on our frontier. Save when we have had to deal with the resistance of some village which we had set out to punish for raiding or some such offence, no column with which I have been has had to fire a shot, even when approaching some village to which no white man had ever been before.

Why are these hills so hard to penetrate? There are several reasons. The climate is bad for much of the year. The rainfall is one of the heaviest in the world, and mosquitoes, leeches, sandflies, and other pests abound. The Anopheles mosquito is plentiful, and many of them are infected. I do not think there was a single European official in the Naga Hills last year who did not have malaria. Transport is another difficulty. There are no bridle paths save in the administered area. Beyond that there are only Naga paths, very steep and so narrow that a column has to march in single file. All baggage has to be carried by men, who require a baggage guard in hostile country. Then there is language. Often one village cannot understand the language of the next, and this leads to interpreting through several mouths, with all its inconvenience and danger of serious misunderstanding. But the greatest obstacle to exploration is the warlike nature of the tribes. They are intensely suspicious of strangers. Yet one cannot avoid them, for the only paths are those which lead from village to village. One is therefore compelled to visit, and generally to pass through, the villages. Inside a village the path often becomes a narrow street between houses set so closely together that one is continually brushing past front posts and ducking under eaves. A column would be helpless to defend itself in such a situation. Even between villages the jungle is so thick that ambush, the usual Naga method of warfare, is always possible, and where there is any likelihood of attack a column can only move at a snail's pace with flankers hacking their way through on either hand. The very nature of the country, too, makes travelling difficult. Along the base of the hills runs a broad strip of heavy forest; then come heavily wooded and excessively unhealthy foothills. Further in, the mountains are often very steep

and run up to over 12,000 feet. All ranges lie directly across one's path as one goes towards Burma, and have to be crossed one by one, for there are no tracks along the valleys. The rivers are swift, and are crossed only by a few precarious cane bridges. Usually one has to ford, and as they rise quickly one may easily be cut off.

But it is the Naga tribes who constitute both the chief interest of the area and the chief hindrance to exploration. Though their home is included in India, they are not Indians at all in the ordinary sense of the word.

We will begin our journey at the southern end of the district and pursue a tortuous course to the northern end. The first tribe we encounter are the Kacha Nagas. Like all Naga villages theirs were very strongly defended in the old days, and though this area has long been taken over the old defences still exist. Many of the villages are surrounded by a deep, impenetrable thicket of living cane, often reinforced by a deep ditch, which formerly bristled with "panjis"—sharp bamboo spikes which will go clean through a man's foot. The entrance is through a tunnel under the cane, which is held up by stakes, and across a single plank over the ditch. In the event of attack the stakes would be removed, allowing the cane to drop and block the tunnel, and the plank taken away. Such methods of defence are still in everyday use in villages in the unadministered area. What strikes a traveller in their country chiefly is their love of dancing. Their dances are pretty, and they are always ready to oblige with a performance. For a dance a man wears his ordinary dress of a black kilt ornamented with lines of cowries, and a white cotton belt, but for the occasion he whitens his legs up to the knee with lime and wears very artistic feather ear-ornaments. Girls, on the other hand, wear special skirts of dark blue, red, and white, and stomachers of dark blue ornamented with cowries and whorls of white dog's hair dyed red. The effect is most picturesque. But they are a backboneless people, and have long been under the dominance of the vigorous Angami, whom we come to next. It was his raids on the plains which first led us to take over the Naga Hills, and it was he who gave us most trouble when we had done so. In 1879 Khonoma villagers killed the Deputy Commissioner as he was approaching their village and took his head and those of most of his escort. They then rose and, joined by part of Kohima village, besieged Kohima fort with such vigour that they were within an ace of taking it. It was only after hard fighting that Khonoma was finally crushed, and it was there that Colonel Ridgeway won the Victoria Cross in 1880. The Angami in full dress is a wonderful sight. He wears a huge fan-shaped headdress of hornbill feathers, and highly coloured crossed baldricks over his chest. Like the Kacha Naga, he wears a kilt. The women are more plainly dressed. A girl keeps her head shaved till she is engaged, when she allows her hair to grow. Huge brass earrings are worn in some villages. The most remarkable thing



Provincial Boundary ——·——·——
District " ——··——··——
Heights in feet.

SKETCH-MAP OF NAGA COUNTRY

Note: This map is taken from the most recent materials available. The copies of the latest surveys have not reached England.

TIZU VALLEY FROM BAIMHO. SEMA NAGA

KHONOMA. ANGAMI NAGA

about his country is the way he has terraced the steep hillsides for irrigated rice cultivation. These terraces are marvellous works when one remembers that they are made without any surveying instruments whatever. Water is led in channels from streams, often for miles round the shoulder of a hill. It will irrigate a terrace perhaps half a mile long, be allowed to run down to the next terrace, and irrigate that, with a very gentle flow back to a point only 6 or 8 feet below where it originally left the artificial channel. Terraces of this kind are found in the Philippines, in Borneo, and in many parts of Eastern Asia, and the fact that they are found in the Naga Hills opens an interesting problem of migration. I shall have to mention later the way in which Naga tribes who do not practise terraced cultivation seem to be altering the face of their country, and the possible effects of this. The Angamis, by adopting this method of making terraces, seem to have stabilized things. The same terraces are used year after year, and there is very little loss of soil; they carefully conserve their forests too, so that the water supply, on which the success of their terraced cultivation depends, may remain constant. But the face of the country *is* changing all the same, though very slowly. The rock is a very unstable shale which will bear no weight. The result is that terraces sometimes go sliding downhill, and this winter some of Kohima station has gone.

From the Angamis we come to the Semas, a cheerful and very warlike tribe, most of whose territory lies on the Chindwin side of the watershed: for it is to be noted that the watershed between Assam and Burma has not been adopted as the boundary. Some of the tribe is administered, and some is independent. The Angami is a democrat, and every man does that which is right in his own eyes, but the Semas have very autocratic chiefs, each in his own village ruling his subjects with a rod of iron, and on the whole very justly. Probably no race in the world can boast a dress more picturesque and striking than that of a Naga warrior. Among the Semas, Lhotas, and Aos it is as follows. On the head is worn a deep fillet of bear's hair on a cane frame, which is decorated with the black-barred tail feathers of the Great Indian hornbill. One or sometimes two embroidered baldricks with deep fringes of scarlet goat's hair cross the chest and support behind a tail of human hair and scarlet goat's hair. This tail is really a glorified "panji" carrier. In front the warrior wears an apron of black cloth entirely covered with close lines of cowries, and on his wrists are cowrie gauntlets with scarlet fringes. Above the elbow he wears heavy ivory armlets. His weapons are a long spear with a shaft entirely covered with scarlet hair ending in a deep fringe, and a "dao" with a tuft of scarlet hair on the handle. Sema women as a rule leave the upper half of the body uncovered. Girls engaged to be married wear fillets of plaited scarlet cane and yellow orchid stalk. Peace has few charms for this vigorous people, and chiefs on the administered side of the Tizu envy their brothers across the

frontier who can still add spice to life by an occasional raid. A remarkable feature about the tribe is the way in which they increased about two generations ago, many of the chiefs having families of between twenty and thirty. The result was overcrowding and shortage of land. They expanded at the expense of their less warlike neighbours, but were eventually held on all sides, and the overcrowding still exists.

Their method of cultivating rice, job's tears, and millet is that known as "jhuming." The jungle is felled and allowed to dry. It is then burnt and the ashes dug into the soil, and the crop sown. The same area is used two years in succession, and is then abandoned until enough jungle has grown up for it to be used again—usually from five to ten years. Of course, the thicker the population the shorter the period of rotation before the same land has to be used again, and the less chance the jungle has of growing up. The less the jungle grows up the more the soil is denuded, and the less soil there is the less jungle there will be in future; and so on in a vicious circle. A secondary effect is that the less roots there are in the soil the less is rain held up, and the more quickly do torrents come down in flood.

The denudation is terrible. Once from a hilltop after some heavy rain I could count no fewer than thirty-six new landslips on the opposite side of the valley over which I was looking. Scores of tribes in Assam and Burma practise "jhuming," and what is going on in the Sema country is only an example of what is happening over a huge area. Vast quantities of soil are carried down the rivers, which deposit the silt as they slacken speed in the plains. One result has been the gradual growth of huge sandbanks at such places as the junction of the Brahmaputra and Ganges near Goalundo. These in turn hold back the water and cause floods, which do an immense amount of damage to crops in the plains. I do not mean to imply that sandbanks would not be caused in any case. But the amount of silt brought down by rivers flowing through virgin jungle is very different from that carried by streams fed from steep hillsides covered with freshly dug soil on which rain has been pouring at the rate of half an inch an hour or more.

Altogether, the problem is a difficult one. To forbid "jhuming" is impossible: it would condemn thousands of people to starvation. Moreover, "jhuming" by tribes who are not compelled by pressure of population to use the same land too often, and who leave a reasonable number of trees standing on the land, probably does no harm at all. It is in the crowded areas such as the Sema country that the harm is done. There we are trying two remedies with some success. We have been sowing quick-growing trees, such as Nepal alder and acacia, which will hold the soil, and we have been teaching Semas to terrace like the Angamis.

This "jhum" cultivation is one of the most primitive and probably one of the earliest methods of those employed by man, and must, it seems, have preceded irrigation. One wonders whether it was not one of the

causes of desiccation of large areas of the globe. Possibly hillsides which are now bare rock were once covered with forest. As this was "jhumed" denudation would set in, and the destruction of forests would cause a diminution of rainfall, and so eventually desiccation. It is interesting to think that in watching a hillman of Assam "jhuming" his land we may be watching an agricultural process which has had an incalculable effect on geography and human history.

East of the Semas one gets into little-known country, a striking feature of which is the fine pine forests which clothe many of the hillsides. In spring the pines and the young grass and the scarlet rhododendrons make a picture one can never forget. In 1924 I went as far as Kipirr, which had never hitherto been visited. We had an excellent reception, and I even had a friendly visit from some people from the east bank of the Ti-ho. The Saramatti range, which is covered with pine forests almost to the summit, was in full view only just across the valley, and I was able to see down the valley through which the Ti-ho runs as it makes a sudden turn towards Burma. It was quite clear that the land falls away quickly on that side towards the Chindwin. To the north I was able to obtain an excellent view of a portion of the little-known Yinitsung country. It is thickly populated, and nearly every commanding ridge was crowned with a powerful village. We have been little in touch with this tribe and know little of them. For one thing, they prefer to be left to themselves, and for another, embassies from them can only reach administered territory after a precarious journey through the Sema or Chang country. The Southern Sangtams, who inhabit the country round Kipirr, expose the heads of their enemies on poles. It is not mere lust of slaughter that impels a Naga to take heads. He certainly rejoices when he can bring home tangible proof that he has killed his enemy, but he also believes that by bringing home the head of an enemy he also brings home his soul, and so adds to the supply of "soul-force" in his village, thus increasing its fertility and prosperity. It is for this reason that the head of an enemy is placated with small offerings and it is urged to call its relations and friends so that they too may be killed. Head hunting still goes on in the unadministered area, but by definitely expressing disapproval of it Government is gradually causing it to cease, without taking over and directly administering the area. All villages being continually on their guard, the number of casualties due to head hunting is very small indeed.

Coming back through the Semas we strike the Lhotas, a tribe which centres round Wokha Hill, a fine isolated peak of over 6500 feet, which is a landmark for miles around. Under it the Semas, Lhotas, and Aos believe the Land of the Dead to lie, and on the east face of it is a conspicuous line of white rock, which they regard as the Road of the Dead. North-east of the Lhotas lie the Aos, a large and important tribe, living in huge villages on the tops of the ranges which run through their country.

They are an interesting people, and among their curious customs is that of exposing their dead on platforms instead of burying them. These platforms are arranged in rows flanking the paths up to the villages, which are thereby rendered very unpleasant to approach at times. The workaday dress of the men both among the Lhotas and Aos consists of a strip of cloth pulled up between the legs from behind and tucked through the belt so that it forms a flap in front. Over the shoulders they wear a cotton cloth. There is an enormous variety of these, varying in pattern with the status of the wearer and the number of Feasts of Merit he has given. Similarly the skirts of Ao women vary in pattern according to their status and clan. Woe betide a lady who sports a skirt of a pattern to which she is not entitled! All well-to-do women wear magnificent strings of cornelian beads, even when working in the fields. The Aos leave large numbers of trees standing on the "jhumed" hillsides, and this method of cultivation as practised by them does not seem to cause any abnormal denudation of the soil.

The peculiar characteristics of the country are particularly well shown in the portion inhabited by the Aos and Lhotas. You have a series of very long, straight ranges, running parallel with each other and with the Brahmaputra. The streams therefore have to run for many miles at right angles to the course they must finally take to reach the Brahmaputra, and eventually only escape through gorges cut through the ranges. The impression one gets is that the streams have great difficulty in getting out of the hills at all.

Another characteristic is the levelness of some of the valleys. Some of the valleys have no heads, if one may put it that way. Instead you will find a stream flowing out at either end, the watershed dividing the two sources being so low as to be hardly perceptible to the causal observer. These valleys are a great snare to the unwary geographer who tries to make maps from the tops of the ranges without going down to the valleys to see which way the streams really run.

I will not deal with the Changs, who lie to the east of the Aos, as I was laid up with leech-bites and unable to accompany Dr. Hutton when he toured in the country in 1923, visiting many villages to which no white man had ever been. North of the Aos are the Konyaks. This term covers what is really a number of different tribes, but they extend an unknown distance to the east, and we do not yet know enough about them to be able to subdivide them properly. Only a small number of their villages lie in administered territory. The tribe which is giving the Burma Government so much trouble with its human sacrifices belongs to this section of the Naga race. The Konyaks differ markedly from all the Naga tribes I have hitherto described in this paper. The staple diet in most places is taro instead of rice; their costume is distinctive in its scantiness; their artistic sense is very high; and, while all other Naga clans are strictly exogamous, they possess an endogamous

RAIDERS RETURNING TO SAKHALU, SEMA NAGA

COLUMN CROSSING "JHUMI" LAND, TANGSA, KONYAK NAGA

CHINLONG, KONYAK NAGA

MUNGCHEN VILLAGE, AO NAGA

WEALTHY COUPLE AND HOUSE, KICHILIMI NAGA

clan called Angs from which their sacred chiefs are drawn. In the southern and western portion of their country the men constrict their waists to an amazing smallness with cane or bark belts. In some places this is the sole garment worn, while in other places it is supplemented by an apron. Women in some places wear a skirt reaching halfway to the knee, while in others they wear only a very narrow strip of cloth encircling them low down below the buttocks. Both men and women are elaborately tattooed. Further to the east the men wear crested hats of cane and yellow orchid skin, and very handsome belts covered with cowries ground square and sewn close together. The women have their heads clipped in a peculiar way, save those of servile clans, who have them cropped quite short all over, lest a hair should fall into their master's food while they are cooking. The Konyaks are exceedingly warlike, and possess a highly developed social system. The villages are ruled by sacred chiefs, and a striking feature is the huge " Morungs," which the men of the villages use as their club houses. It is in them that the warriors assemble before and after a raid. They are of great size, and remind one strongly of the *ravi* of New Guinea. The posts are covered with elaborate carvings in high relief of human beings, heads, tigers, elephants, hornbills, and so on. Even larger are the houses of the chiefs in some villages. One I measured was 123 yards long inside. Probably the owner himself did not know how many people lived in its many dark rooms. While in some villages the houses are scattered, in others they are so close together that self-defence would be impossible if one were trapped in one. The gates are well defended and guarded by the " Morungs," from which sloping ladders run to look-outs in trees, so that a man can keep watch from a look-out well beyond the gate and retreat to safety within the fence without coming to earth. The ground round the village is thickly studded with " panjis," which are practically invisible among the dead bamboo leaves. In some places branches are laid across the path to trip up any one running away. Of the warlike character of the Konyaks there can be no doubt. It was they who wiped out an outpost many years ago at Naginimara, where the Dikhu river emerges from the hills ; it was they who once killed almost the whole of a survey party and took an English head, a feat which has only been equalled by Khonoma ; and it was they who ambushed one of our columns some twelve years ago, stampeding the carriers and neatly removing some of their heads as they rushed them. In 1923, Dr. Hutton, Deputy Commissioner of the Naga Hills, and I were fortunate enough to be able to make a tour in the unadministered country to the east. To some of the villages we visited no white man had ever been before. Others had been visited by Colonel Woodthorpe, R.E., about 1875. His visits were vividly remembered, and we were even told, quite casually, in some places how many eggs and chickens had been given him. I only hope he got better eggs than we did. Twice the eggs given us for our breakfast

WEALTHY COUPLE AND HOUSE, KICHILMI NAGA

MUNGCHEN VILLAGE, AO NAGA

in the morning were too quick for us; they were put down too near the fire, and hatched the evening before!

We were able to go nearly as far as the main Patkoi range. No one has ever been to the top in this area and looked over the other side; we, unfortunately, could not do so without exceeding our orders. This was especially disappointing, as we received some particularly tempting challenges. We were considered to be a most unpleasant colour, and doubt was expressed as to whether we should bleed if cut; there was some feeling that the experiment ought to be made. From what we heard, however, it seems quite clear that the country between the top of the Patkoi and the Chindwin consists of low jungle-covered hills, apparently sparsely inhabited. One of our great difficulties was transport. Colonel Woodthorpe took his own carriers with him, but we, for various reasons, decided to pick ours up as we went. We had some trying hours persuading more than semi-hostile Konyaks to carry our loads. Sometimes they would march for an hour or two, and then suddenly put down their loads and refuse to go on, on the ground that the village they were approaching was hostile, and would ambush them on their way home, even if they did not attack as we advanced. For instance, between Yunghong and Angpang we had great trouble. The previous evening Yunghong, who did not in the least desire our presence, had tried to lead us through and right away from their village, intending that we should camp in the jungle and be unable to get carriers in the morning. We saw through the plan, however, and camped close to the village, while the inhabitants looked sullenly on. In the morning we got them to supply carriers with extreme difficulty, and set out. As soon as we reached the stream which divides their land from that of Angpang, their enemies from time immemorial, they put down their loads and collected in the high grass by the side of the path. They flatly refused to enter hostile territory, and things began to look awkward. Eventually we got them started again, only to be met halfway up the hill by a crowd of Angpang, who were very angry that we had brought Yunghong men on to their land. We therefore formed our escort into a cordon between the two angry crowds and sent Yunghong shouting home. Angpang picked up our loads and went up the hill singing of their valour and the cowardice of Yunghong and the rest of the world in general. In the morning they refused to supply carriers on the ground that they had carried the day before. Firmness and persuasion put an end to this objection, however, and once more we set out. Day after day of this sort of thing was wearing, but we got through at last, and had an excellent reception from the Northern Konyaks. From there we regained administered territory, and out troubles were at an end.

For all its malaria, mosquitoes, and leeches the country must be one of the most beautiful in the world. It is hard work, toiling up the hot steep slopes, but one is rewarded on the heights with unsurpassed views

of green mountains, shading into blue, with a cloudless sky above, while away to the north one can often see the snowy ranges of the Himalayas. The people are primitive—long may they remain so—but they are exceedingly picturesque, cheerful, brave, and loyal. When the call came for men for the Naga Labour Corps for France, they came forward with wonderful readiness. Many who came were independent—just friends of the British Raj, ready to help, not subjects. All these men knew nothing of the sea, nothing of any land but their own. Yet they faced the unknown, and went. Some never came back to their green hills.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: To-night you are to have the pleasure of listening to Mr. Mills, of the Indian Civil Service, who has been governing one of the extreme corners of our Empire. He is to tell us about a range of mountains which, though included within the Empire, contains people over whom we, apparently, have little authority and about whom we have even less knowledge. Mr. Mills is singularly well qualified to speak to us about those people, because not only has he been an Administrative Officer, but he is keenly interested not merely in the geography of the country but also in the anthropology of the tribes, a rather rare combination; it is only fair, however, to remember that in recent years our Government in various parts of the world, not only upon the fringes of the Indian Empire but also in the Sudan and other places, has encouraged anthropological study. We need not say how laudatory that is and how very much the power of Administrative Officers to administer properly their districts is enhanced, if they set themselves to work, as Mr. Mills has done, from the first to gain a knowledge of the peculiar customs and the peculiar ideas of their peoples. It is certainly strange, and I think you will agree it is so when you have heard Mr. Mills, that there should be within such comparatively easy reach and between two such well-known and such thoroughly administered provinces as Assam and Burma, a range of mountains sheltering a number of tribes in the extremely primitive state, both technologically and psychologically, in which these tribes are. Without delaying further, I will ask Mr. Mills to read his paper upon the frontier between the provinces of Assam and Burma.

Mr. Mills then read the paper printed above, and a discussion followed.

Mr. F. KINGDON WARD: I know the Naga Hills only from the point of view of the visitor; but although I have met Mr. Mills to-night for the first time, I heard of him no less than eight years ago, when I spent a short holiday in those hills, and I came here to-night in the hope of hearing something of the botany of that country, because I have long looked longingly at the Patkoi range to which Mr. Mills referred. The lecturer spoke of the possibilities of a railway, and perhaps in years to come we may look forward to such a railway. He said the reason why it probably would not be made was because it would not pay. I do not think that economic questions of that sort enter into the question of frontier railways in India. It is almost entirely a strategic question. If there was any danger of invasion on the north-east frontier of India, at whatever cost, I think a railway would be built immediately. But, as we have seen from the photographs, it is a country in which there is no fear of invasion from beyond the border on a big scale, and we may wait very many years before any railway is built.

There was one point to which the lecturer referred on which I am bound to say that I join issue with him. He suggested that as the forest is cleared away the rainfall naturally ceases. Personally I have always learned that where there is a heavy rainfall there is heavy jungle. Mr. Mills rather wants to put it the other way, and he says if the forest is removed the rainfall will cease. I should like to ask him on what ground he draws that conclusion. I have heard if forest is cleared away the rainfall is apt to become a little less, but I do not think that such an almost world-wide phenomenon as the Monsoon would cease because the jungle was removed! My own knowledge of the Naga Hills is confined to what one might call the absolute fringes of it, to Kohima, the administrative centre, where I spent a short holiday in trying to climb Japvo, a mountain about 10,000 feet high—a very simple matter. It is only four days from Kohima, but in climbing up the steep jungle-clad side of the mountain one got some idea of the immense difficulties which officers on the frontier have to overcome.

I have been very much struck, if I may say so, by the youth of the lecturer, because when I heard of him eight years ago I always heard him referred to as a very seasoned officer who had done extraordinarily good work on the frontier, and one thought of him rather as a veteran. We owe these officers a great deal, when we consider the extraordinary difficulties which they have to overcome.

I happened to be in Kohima when the Naga coolies came home from France. I think they were about 1000 strong, and a great festival was held in Kohima, to which all the tribes sent their warriors to dance. I have no doubt that Mr. Mills, who was then at Mokokchung, sent in some of those contingents. It was a very fine display. We saw Angamis, Aos, Semas, Lhotas, and others doing their dances dressed in full war paint, and it was really an extraordinary thing, which gave one some insight into the work done by these frontier officers, that these people should be willing to come in and give such a magnificent display. I remember that several of the warriors who had come home from France joined in the dance wearing German helmets, which they had picked up on the field of battle.

I am a little disappointed that Mr. Mills has not told us something about that mysterious mountain, Saramatti, which he mentioned once or twice, and which he saw. It is a goal on which many of us who are, like Mr. Mills himself, naturalists, have had our eyes for many years. I hope that on some future occasion Mr. Mills will reach the top of Saramatti and tell us something of its flora and fauna.

The PRESIDENT: Would any one else like to add anything, or to put any questions to Mr. Mills? If not, I should like to ask Mr. Mills if he could tell us in two or three words something about the racial families to which the people referred to belong. To me they seem singularly unlike what I expected to see, and I was very much intrigued about possible connections with the South Sea Islands. Will he say whether we have a Polynesian race in these hills, and, if so, how it came there?

Mr. J. P. MILLS: I had a good look at Saramatti. It is clothed with Khasia pine nearly up to the summit, which is shale. It has snow on until about the end of April. I have not been up it. No one ever has, so far as I know. There is a question whether it has any takin on it. I got a takin's head from an abandoned Kuki village during the rising, and I heard indirectly —I could not get hold of the owners, naturally—that it had been killed on Saramatti. I got a certain amount of confirmation, but no one I ever saw had

SAKHALU, CHIEF OF SAKHALUNAGAMI, SEMA NAGA

MEN OF WANGLA, KONYAK NAGA

MAN IN FULL DRESS, MOKONGTSÜ, AO NAGA

MAN AND GIRL OF LONGCHANG VILLAGE. AO NAGA

DAUGHTER AND NIECE OF CHIEF OF BAIMHO. SEMA NAGA

MAN AND WIFE. CHADUMI VILLAGE. E. ANGAMI NAGA

himself killed a takin there. But I kept the head in case one ever got there again. The question formerly was whether there was sufficient area at over 10,000 feet to hold takin, but since that head was obtained takin have been found flourishing at 5000 feet in the Mishmi country.

As to the racial affinities of the Naga, that is a question which no one has ever settled with any satisfaction. They certainly have a Mongolian basis. They are chiefly Mongolian, with possibly a little Negrito blood in them, and they also certainly have affinities with some of the South Sea people. There are similarities of custom; even similarities of words. You can trace some words straight down from the Naga Hills as far as New Zealand. What seems to have happened is that a lot of people came through from the north somewhere and left an offshoot in the Naga Hills, and as they went along left more offshoots in Borneo—the people who made the terraces—and on right through the South Sea Islands. That is the theory which I am inclined to hold, but until we have far more evidence it is not a question we can settle with any certainty. I think I have answered all the points, and I thank you for listening so long.

The PRESIDENT: We have had a singularly interesting paper to-night which has touched on more different aspects of a country than usual. I think I need say no more, because your ready response to the half-sentence I have uttered has already shown how keenly you have all appreciated the interest of the paper. I have not the smallest doubt that you will give to Mr. Mills evidence of your keen appreciation and of your real gratitude to him for what he has told us to-night.

THE ALPS AND WEGENER'S THEORY

Prof. Leon W. Collet, Hon. Corr. Member R.G.S., Dean of the Faculty of Science and Professor of Geology in the University of Geneva.

Read at the Afternoon Meeting of the Society, 14 December 1925. Folding Plate following p. 304.

FROM north to south the principal subdivisions of the Western Alps are as follows:

(1) *The Pre-Alps*, a very distinctive zone stretching from the Lake of Thun to Lake Geneva and the River Arve.

(2) *The High Calcareous Alps*,* which with their greater height and accompanying glaciers are readily distinguished from (1). South of them rise the following crystalline Hercynian massifs (3) and (5).

* The principal peaks which belong to the High Calcareous Alps are, from south-west to north-east, the Range of the Fis, the Mont Buet, the Peak of Tenneverdze, the Mont Ruan, the Tour Sallière and the Dents du Midi, the Dents de Morcles, the Diablerets, the Wildhorn, the Wildstrubel, Balmhorn, Doldenhorn, Blumlisalp, Gspaltenhorn, Jungfrau, Mönch, Eiger, Wetterhorn, Titlis, Urirotstock, Pilatus, Tödi, Glärnisch, Churfirsten, Säntis.

From a geological point of view, the High Calcareous Alps belong to the Helvetian Folds. These represent the sedimentary cover of the Foreland which has been folded owing to the travelling northwards of the pennine recumbent folds (see Figs. 11 and 13).

(3) *Aiguilles Rouges of Chamonix and Gastern Massif.*
(4) *The sedimentary Zone of Chamonix* and *The Zone of the Paragneiss of the Lötschental.*
(5) *Mont Blanc* and the *Massif of the Aar;* and south of these
(6) *The Pennine Alps* (crystalline), with across the watershed
(7) *The Zone of Canavese* or *The Zone of Roots;* and finally
(8) *The Calcareous Alps of the South* or *Dinarides.*

Let us look now at the evidence which has led to the conclusion that the Alps are fashioned out of a great pile of recumbent folds or nappes.

Long before Heim, Escher, during the years 1840–1850, conceived the idea of overthrusting. It was not, however, until 1870 that the famous section of the Glarus Double Fold was published with Heim as its warmest adherent. The subject is too familiar to detain us. All that need be said is that in 1883 Marcel Bertrand, following upon his researches in Provence and his visit to the North-West Highlands, substituted a single for a double fold. Suess in 1892 supported Bertrand's interpretation, and in 1903 Heim at last followed suit.

While discussion still continued regarding the double or single folding of Glarus, Schardt studied the Pre-Alps. During the five years 1890–1894 he realized that in this extensive district Trias is continually to be found overlying Tertiary sediments; and guided by this relationship, and by a just appreciation of facies considerations, he announced that the Pre-Alps are constituted of a succession of far-travelled thrust-masses of southern origin. Lugeon during 1894–1895 combated this idea, until, won over in 1896 by the accumulated force of his own observations, he began to demonstrate the fundamental *rôle* of nappes not only in every region of the Alps, but also in the Carpathians, the Apennines, and Sicily. And now to Argand,* a pupil of Lugeon, we owe a synthesis of the formation of the Western Alps, based upon a knowledge of the subject such as belongs only to genius.

Beginning in 1905 Argand, as a result of his researches in Piedmont, was led to study the Pennine Alps, where he determined the existence of six gneissic recumbent folds or nappes. The investigation was long and difficult, but it threw light on the mode of formation of the whole chain. We shall make use of Argand's sections and explanations:

Argand started from the notion of the geosyncline, so splendidly developed by Haug and destined to remain for all time one of the basal conceptions of tectonics. His equipment included a very detailed stratigraphical knowledge, and armed with this he has succeeded in straightening out the recumbent folds, and in thus reconstituting the Alpine region at various stages of its development when the general geosynclinal depression was subdivided by geanticlinal ridges. In the diagram (Fig. 1) showing an Alpine chain in embryonic stage, we may note:

* E. Argand, "Sur l'arc des Alpes Occidentales," *Eclogæ Geologicæ Helvetiæ*, 14, 1, Juillet 1916.

1. The Foreland, with granitic batholiths of Upper Palæozoic (Hercynian) Age.

1′. A swelling at the inner margin of the Foreland determined by the push of the nappes. This swelling we may name the Helvetian Geanticline.

2. The Epicontinental Sea.

3. The Foredeep, or Geosyncline of the Valais.

4. The Frontal Cordillera or Geanticline of Briançon.

5. The Intermontane Depression or Geosyncline of Piedmont.

6. The Second Cordillera or Geanticline of Dolin.

g′ shows where Hercynian granites involved in recumbent folds are in part transformed by movement and recrystallization into ortho-gneiss.

b shows the place of origin of certain grits and conglomerates found in the Carboniferous, Permian, Lower Trias, Liasic and Tertiary deposits of the Alps.

b′ shows another similar position and illustrates the intrusion phenomena of the Greenstones, guided by the dislocations upon which the Geanticline of Dolin advanced.

v′ shows how the basic magma of the Greenstones escaped at places into the Piedmont Geosyncline, where it consolidated in large measure as pillow lavas.

The diagram (Fig. 1) shows each geanticline of the embryonic Alps as a recumbent fold. Behind the last geanticline should be found what Suess calls the Hinterland of the chain. The *Foreland and Hinterland constitute the boundaries of the great Alpine Geosyncline diversified by its included geanticlines. Together they recall the two jaws of a vice.* Termier, director of "the Service geologique de France," has shown how the approach of the two jaws has led to the compression of the geosyncline, and thus to the development of the Alpine chain. All this will be realized more clearly if we examine Argand's representations of the evolution of mountain systems.

At the close of the *Middle Carboniferous* the beginnings of the two principal nappes show themselves as simple Hercynian anticlines in the great geosyncline (Fig. 2).

In the *Middle Trias* these two embryonic nappes locally rise out of the waters, but the Piedmont depression, 5, continues tolerably deep, as shown by the character of its sediments (Fig. 3).

In the *Lias* (Fig. 4) a strong horizontal push is felt. The embryos develop, while the depressions deepen. This is the period of accumulation of the well-known Breche du Telegraphe (see *b*, Fig. 1).

In the *Middle Jurassic* the Briançon embryo 4 emerges (Fig. 5).

In the *Upper Jurassic* a lessening of horizontal pressure leads to a general slight submergence (Fig. 6).

In the *Middle* and *Upper Cretaceous* the nappes of the Southern Alps, including the upper nappe of the Pre-Alps, start on their journey

(their Hercynian cores are marked 8 in Fig. 7, their Mesozoic envelopes 8′).

In the *Middle Nummulitic* and *Lower Oligocene* a vigorous push makes itself felt (Fig. 8).

In the *Middle Oligocene* an organic paroxysm supervenes in which five principal phases may be distinguished:

St. Bernard Phase (Fig. 9).—The Briançon Cordillera makes its main advance, developing into the complex nappe of the Great St. Bernard, 4. The sediments of the Valais Foredeep are driven forward to yield the nappes of Simplon and Ticino, 3, and also the lower nappes of the Pre-Alps, 3′. The Foredeep itself is correspondingly displaced and begins to receive the Mollassic sedimentation characteristic of the Swiss Plateau, 3‴. The Dolin Cordillera passes into the Dent Blanche Nappe, 6. The upper nappes of the Pre-Alps, 8″, begin to separate from their roots and to be carried forward on the backs of the Pennine Nappes, an inclusive term embracing the nappes of Great St. Bernard and Dent Blanche.

Dent Blanche Phase (Fig. 10).—It is now the turn of the Dent Blanche Nappe, 6. The upper nappes of the Pre-Alps, 8″, are concomitantly discharged in front of the Pennine assemblage on the top of the lower Pre-Alpine nappes, 3′; from these latter a portion is detached and driven forward to constitute 3″, the external zone, as it is called, of this wonderful group of mountains.

Monte Rosa Phase (Fig. 11).—Born of the Piedmont Geosyncline, the Nappe of Monte Rosa, 5, develops strongly. Concurrently there is considerable back-folding in the Nappe of Great St. Bernard. The Simplon and Ticino nappes, 3, attain their maximum, while beneath them the Helvetian Nappes, 5′, come into being.

Phase of Adriatic Subsidence.—The root region assumes a more or less vertical posture (Fig. 12).

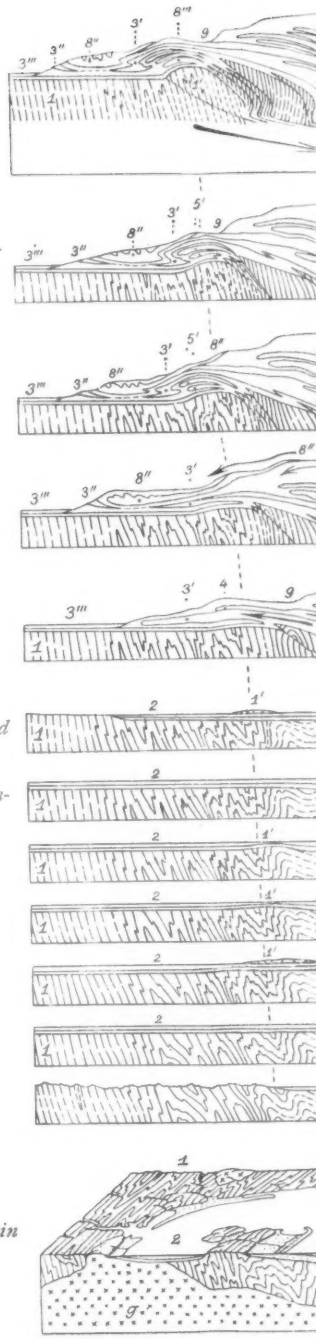
Phase Insubrienne (Fig. 13).—A fan arrangement of the roots is next developed. *The Alps and Dinarides thus face in opposite directions.* The Morcles Nappe and similar parautochthonous folds (8‴ above 1′, Fig. 13) originate beneath the Helvetian Folds (5′, Figs. 11, 12).

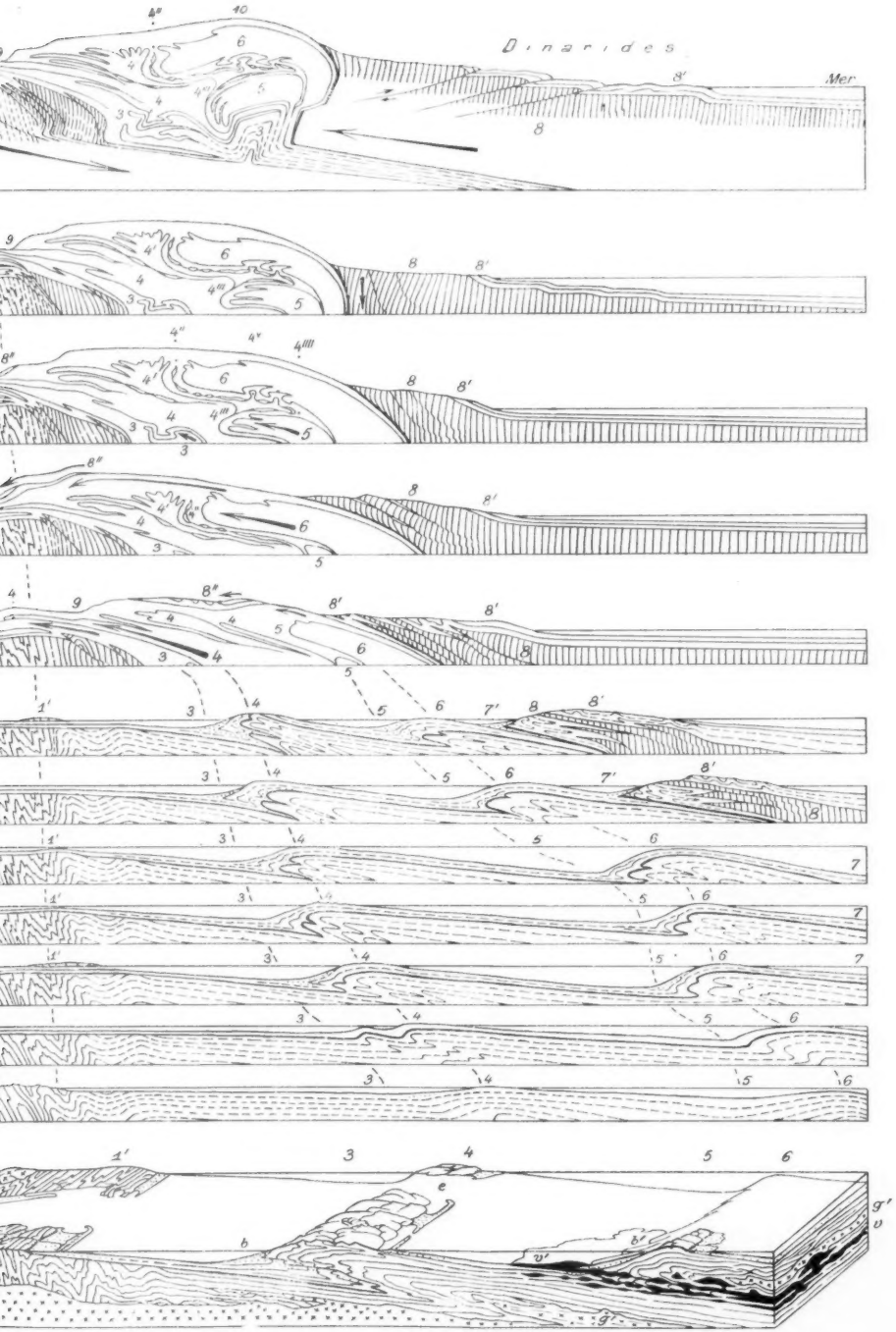
Conclusion.—*The southern jaw of our vice (Indo-Africa of Argand) has approached the northern jaw (Europe) overriding it, and has led to the contraction of the great intervening geosyncline along with the two geanticlines which modified its initial simplicity. These two geanticlines have developed into the two dominant nappes of the Alps, namely, the Nappes of Great St. Bernard and Dent Blanche.* To begin with, these two nappes, both of them Pennine Nappes according to current classification, existed alone. As time went on they found themselves moving in a throng. The Great St. Bernard Nappe set in motion the Simplon assemblage, while the Dent Blanche Nappe operated the Monte Rosa group.

THE FORMATION OF THE WESTERN ALPS:

Showing the principal stages of development.

From the paper by Professor Emile Argand, "Sur l'arc des Alpes Occidentales," Eclogæ Geologicæ Helvetiæ, xiv. 1, *July* 1916.


13. "Phase insubrienne."
12. Phase of Adriatic subsidence.
11. Monte Rosa Phase.
10. Dent Blanche Phase.
9. St. Bernard Phase.
8. Middle Nummulitic and Lower Oligocene.
7. Middle and Upper Cretaceous.
6. Upper Jurassic.
5. Middle Jurassic.
4. Lias.
3. Middle Trias.
2. Middle Carboniferous.
1. Embryonic state of a chain of Alpine type.



COLLET · ALPS

The *nappes of the High Calcareous Alps* (based upon 1′, Fig. 13) *owe their existence to the forward drive of the Pennine Alps.*

Suess had already shown that the "Alpides" were due to the approach of Hinterland and Foreland. But in his idea there were two directions of thrusts; one towards the north and the other towards the south. Argand shows, in 1912, that we have to deal with only one great push towards the north, with an underthrusting at the end of it. We find just the same, on a much larger scale, in the Himalayans, where the northern part is an overthrust northwards and the southern part an overthrust southwards. They are nevertheless parts of the great northwards movement. (E. Argand, "Le rythme du proplissement pennique et le retour cyclique des encapuchonnements," *Procès Verbaux Bulletin Société Vaudoise des Sciences Naturelles*, t. **48**, 20 Mars 1912; and E. Argand, "La Tectonique de l'Asie," *C.R. Congrès Géologique International Belgique*, 1922.)

If we arrange now the different parts of the Alps from a tectonical point of view, we arrive at the following groups:

1. The Massifs of the Aiguilles Rouges of Chamonix and of Gastern.	The Foreland.
2. The sedimentary Zone of Chamonix and the Zone of the Paragneiss of the Lotschental.	
3. The Massifs of the Aar and of Mont Blanc.	
4. The High Calcareous Alps (Helvetian Folds).	
The Pennine Alps.	The Geosyncline.
The Austrides of Dinarides.	The Hinterland.

The Massifs of the Mont Blanc, Aar, Aiguilles Rouges of Chamonix, Gastern are of Hercynian age. Farther to the south-west the Foreland is represented by the Massifs of the Pelvoux and Belledonne, then by the Massif of the Mercantour (Argentera of the Italians), all of Hercynian age, with a folded sedimentary cover.

Prof. Argand showed that the austro-alpine nappes belong to the Hinterland: that is, to Africa or Gondwanaland. Therefore the higher Préalpes, that can be seen from Geneva, Lausanne, and Berne, represent a small part of Africa resting on Europe or Eurasia. These important views sketched by Argand in his famous paper "Sur l'Arc des Alpes Occidentales," stated precisely at the Brussels Congress, have been accepted by Staub in his valuable memoir 'Der Bau der Alpen.'

On the base of Argand's results Dr. R. Staub found in the north-eastern part of the Swiss Alps the pennine elements covered by six higher nappes belonging more to the type of the "thrust-masses" of the north-western Highlands of Scotland than to the type of the recumbent folds of the Pennine Alps. This series of nappes has been named by Staub the Austrides, for they form the main part of the Austrian Alps.

Staub's "Austrides" represent what Termier and Argand had called, in a much more general way, the austro-alpine nappes.

For the Swiss geologists the forward drive of the Hinterland towards the Foreland cannot be denied; it is almost a matter of fact, that is splendidly summarized in Staub's geological map of the Alps.

The intrusion of basic magma in the dislocations upon which the Dent Blanche Nappe advanced (see Fig. 1) is also a matter of fact. I have seen myself the evidences on the field, guided by my friend Argand, and I have shown them to many English geologists during my summer course in the Alps in 1924.

I must state explicitly that all these results have been obtained independently of Wegener's hypothesis. That is why I think that they are a great support to Wegener's theory.

CONCLUSION.—A southern continent (Africa or Gondwanaland), made of Sial, is separated from a northern continent (Europe or Eurasia), also made of Sial, by a geosyncline or the sea of Tethys of Suess. The southern continent being drifted northwards, the floor of Tethys thinly coated with Sial has been folded (geanticlines) northwards, thus forming a mountain chain (the Alps). Sima has been injected into the laminated reversed limb of the geanticlines. The southern continent not only encountered the obstacles formed by the northern continent, but its frontal part has been thrust over it.

By the employment of Wegener's ideas we could go a good deal further and—as shown by Argand and Staub—arrive at accepting a northward drive of Europe, producing a distension to which the Mediterranean is due. But my intention this afternoon is to insist on the travel of the Hinterland towards the Foreland of the Alps, and to point out the importance of the gabbros of the reversed limb of the Dent Blanche Nappe.

As shown by Lord Rayleigh, many facts make it necessary to abandon Kelvin's classical theory of the cooling of the Earth. The work done by Prof. Joly in this direction is of great value, and it will be soon impossible to resist Wegener's attractive ideas.

Before the paper the CHAIRMAN (Mr. DOUGLAS W. FRESHFIELD) said: A week ago I had to protest to our evening meeting that I am no geologist. I do not even pretend to be able to understand many of the esoteric terms of the modern Continental school of geologists. It is therefore plain that in the position in which I find myself to-day I am one of what Mr. Thomas Hardy might call "Life's little Ironies." Still I am glad to be here, for although I cannot say much on the theories we are to discuss I can promise to introduce to you a lecturer who is a master of his subject. Professor Collet is Dean of the Faculty of Sciences in the University of Geneva; he has made a long study of the Alps and knows all the latest theories, which probably will not be the last, about their formation. I am glad also to be able to record a debt I owe to Professor Collet. Nearly forty years ago I observed that the streams that came out of the glaciers in winter were not the result of glacier-melting,

but came from mountain springs whose sources were under the ice. Nobody took any notice; at any rate, the text-books went on writing about the glaciers melting in winter, until Professor Collet analyzed the water of the Grindelwald Glaciers and found that it was pure fountain-water from mountain springs rising under the bed of the ice. I will not detain you any longer, but ask Professor Collet to give his lecture.

Professor Collet then read the paper printed above, and a discussion followed.

Mr. E. B. BAILEY (Geological Survey, Edinburgh): It is a very great privilege indeed for British scientists to receive at first hand from Professor Collet an account of the wonderful renaissance of Alpine tectonics—a renaissance which dates back to 1893, when, as we have heard to-night, Professor Schardt produced his interpretation of the pre-Alps. I may say that for the next fifteen years—and this it is very important for us to realize, because it enables us to understand how thoroughly the new interpretation has been tested—practically every Alpine geologist who was worthy of the name stood up against Schardt, and produced this criticism and that criticism. Our lecturer was, fortunately for us, just old enough to take part in the initial criticism of Schardt's work. I think it is seventeen or eighteen years since I first heard Professor Collet lecturing in Edinburgh on the subject—at that time an infidel, wavering, but still one who had not been converted to the interpretations of the Alps to which we have listened to-night. Of course that is all to our advantage, because we have heard from one who was brought up in unbelief; and, as I say, all other Swiss geologists that we know, men like Heim and Lugeon, were about that time attacking Schardt. Since then every one has been convinced, and has pointed out where the error of his own criticism has lain, and what has brought him to realize the absolute truth of Schardt's interpretation of the pre-Alps. I dwell on the pre-Alps, because they still remain the most wonderful feature in the interpretation of the Alps and at the same time, in a way, the most comprehensible.

When next I heard Professor Collet on the subject of the pre-Alps, we were very much better situated, because we were actually among the pre-Alps; for in 1909 Professor Collet very kindly led a party of three Scottish geologists, of which I was privileged to be one, through the pre-Alps and the surrounding country. The pre-Alps stand up beyond Geneva, and it was explained to us, and we could follow absolutely on the ground, why they are interpreted as a travelled mass, entirely foreign to the district in which they stand. We could examine their marginal relations—could see that they were lying upon the top of the local Alps and stretching out beyond the rest upon the rocks of the great Swiss plain. Not only that, but the pre-Alps are built up of the same geological formations as they overlie. In them there are fossils easily determinable, and these fossils tell us that the pre-Alps are made up of Palæozoic, Mesozoic, and Tertiary formations, just as is the foundation upon which they lie. Not only this, but there is the extraordinary fact that we have had emphasized to-night: that although there are Mesozoic rocks in the pre-Alps and in the foundation, these Mesozoic rocks would never have been compared, and it would never have been realized that they were rocks of the same age, if it had not been for the fossils. The rocks themselves are absolutely different in character. The only possible explanation is that these overlying masses have been developed through sedimentation in another country, and have travelled, have invaded, as it were, and are now resting, a great foreign mass in the heart of Switzerland. They are just as obviously erratic as, say, a

boulder of Shap granite found upon the coast of Yorkshire; but the scale is rather different. The pre-Alps are very much more extensive than the Lake District of England, and, as you have seen in the first photograph, in altitude they are Alps—something much bigger than we have in this country. So you can imagine the bulk of this erratic mass, and that is the very essence of the story of Alpine interpretation.

Behind the pre-Alps, Professor Collet took us to see the great recumbent folds of the Rhône valley that have been interpreted, after or during his conversion, by Professor Lugeon. These folds are in a sense so very simple, that is after they have been worked out by a man of genius, that one merely has to go and see them. They are there on the hill-sides. You take the map and go over them and see that they are there.

Behind the Rhône valley, after a long gap of years, two years ago, I think it was, I was one of a party, and there are others here, who were led by Professor Collet through the much more difficult region of the Pennine range, which had been interpreted by Lugeon and Argand. And here we were on very different ground indeed. It is not, as a matter of fact, difficult to see the great folds. One sees enormous recumbent folds if one walks about, and one can follow them out with the map; but the difficulty in this case is that the rocks have been so tremendously altered by movement and heat that they are, for the most part, in the condition of crystalline schists. There may be some British geologists who would be shocked at the very idea of calling rocks Mesozoic that have garnets in them—that have lost their fossils and have become crystalline schists—but I may say that all Swiss geologists are satisfied that the *schistes lustrés*, even where they have become thoroughly metamorphic rocks, are of Mesozoic age. And when one looks at those great folds in the Pennine Alps with their Palæozoic cores and their Mesozoic envelope—one realizes that here are folds made in the Tertiary movement that has developed the Alps.

Well, then, I must admit that I for one feel absolutely convinced as to the general truth of the Alpine interpretation as it stands to-day. Our Chairman has said that there will be other interpretations. Well, that is true. There will always be improvements, always modifications, and sometimes, possibly, periods of retrogression in the interpretation of the Alps. But the main features that have been worked out by the present generation from Schardt onwards, including many other great workers—and Professor Collet has said nothing to-night of what he himself has done on Mount Buet, and on the Jungfrau, where one has to be not only a geologist but an alpinist of the highest order—all this work has come to stay.

Then of course we have just heard from Professor Collet of Professor Argand's fascinating interpretation of the history of the Alps, starting from the first days long before the great period of Tertiary movement. Of course there is a good deal in this interpretation that is much more speculative than the mere tracing of the structure of the country; but a lot that Argand has told us about the development of the Alps will last for ever. This attempt to build up the history of the growth of the mountain chain is not new; it goes back for about one hundred years. We can find it in the early writings of Studer on the Alps; it is a delightful idea, that of the mountain chain travelling forward, and the pebbles going forward from the chain as it grows, and then the chain riding over its own débris. One finds that in the early writings of Studer, and also in the story told by Argand; and already, difficult as the subject is, I feel convinced that there is a very great measure of truth in what Argand has given us. Professor Argand is, perhaps, at the moment the most brilliant of all the brilliant school of Alpine tectonists.

Finally, if we take the current Swiss view of the structure of the Alps, and the similar view, worked out by that giant of the north, Törnebohm, for the Scandinavian chain, and again the similar view attained by Scottish geologists in their Highlands, we find that some sort of continental drift becomes a matter not of interpretation but of observation.

Mr. PHILIP LAKE (Cambridge): Like others, I have listened with the greatest interest to Professor Collet's account of the remarkable structure of the Alps as developed by the Swiss geologists. I remember well the appearance of Schardt's first paper and the discussion to which it gave rise, and have since watched the gradual conversion of every Swiss geologist, one after another, to Schardt's views. It has always seemed to me to show great open-mindedness on the part of men like Heim and Termier, that they were able to give up their own views and accept the later interpretations. No geologist can now doubt that the Alps have been pushed forward over the foreland and that the hinterland has moved towards the foreland. We have the same thing in other places. The Himalayas were probably formed by Central Asia being pushed over India. But these movements are very different from those imagined by Wegener. The great difficulty in Wegener's theory is to explain lateral movements at all. No force of any magnitude has been suggested to produce such movements. The suggestions which have been made are of very minute forces, which possibly might push the blocks of Sial through the Sima but could hardly produce folding such as we see—folding against the force of gravity. A small force may slowly overcome a viscous resistance, but it cannot overcome a force greater than itself however long it may be applied.

According to Wegener, the movement in the Alpine area should be from north to south; according to Professor Collet it was from south to north. I do not think that matters much, for it is a question of relative movement; but it is a difference. Further, the account which Professor Collet has given us hardly agrees with Wegener's ideas or with his evidence on other points. Wegener fits the two sides of the Atlantic together and from the coincidences which he observes he concludes that the probability is a million to one that his theory is correct. Now, in fitting the two together he supposes that in Carboniferous times Europe and Africa had the same relative positions that they have now. Professor Collet contends that they were farther apart. If they fit with Europe and Africa as they are now, they cannot have fitted when Europe and Africa were farther apart.

But the point which appeals to me most is that the masses of Sial are supposed to be about 100 kilometres in thickness, extending deep down into the Sima, with 4·8 kilometres rising above the latter. The whole thickness of Africa was not pushed over Europe, but only the uppermost layer. I cannot see how that could result from masses 100 kilometres thick pushing against one another. It is a difficulty on any hypothesis, even on the old hypothesis of a contracting interior. Mountain ranges are, apparently, very superficial phenomena, and it is only the outermost layer which is involved in the folds. Wegener's theory certainly offers no better explanation than the old contraction theory.

Mr. T. C. NICHOLAS (Cambridge): It is a great pleasure to me to be present to-night in order to express, even if in an inadequate manner, the great debt which I owe to Professor Collet for the memorable experience of being led by him through a part of the Alps during the summer before last. In the course of that excursion, the pleasure of which was shared with me by Mr. Bailey and other British geologists, we saw evidence for a good deal of what

we have heard from the lecturer this evening, particularly with regard to the structural phenomena of the Pennine Alps. And for my own part I have no hesitation in accepting the general truth of the views now current among Alpine geologists upon the formation of the pre-Alps, High Calcareous Alps, and Pennine Alps by recumbent folding. I think it is quite incontestable that the hinterland has moved for great distances towards the foreland, and that in doing so its long-continued pressure upon the intervening geosyncline has given rise to the immense recumbent folds which Professor Collet has demonstrated to us and of which he has shown us photographs.

But though in my opinion the evidence for the movement of the hinterland towards the foreland is complete and overwhelming, I am not so sure that this evidence can be said to confirm the theory of Wegener, and I should prefer for the present to keep facts and theory separate.

Mr. J. M. WORDIE: As the hour is getting late I wish to make only one remark, and that is to ask Professor Collet if it is absolutely necessary, in the formation of the original geosyncline, to have the foreland and the hinterland pulled apart? Could it not be imagined as formed in some other way? When he drew the diagram he said that according to Wegener's supposition the foreland and the hinterland were pulled apart and the geosyncline formed between them. It seemed to me that there may be other possible explanations.

Dr. J. W. EVANS: I have not very much to add to the discussion, especially after the eloquent speech which we have heard from Mr. Bailey. I was very interested in Mr. Lake's criticism of the references to Wegener. Personally, I do not think that anybody except Wegener himself is prepared to accept everything that he contended for. Wegener's book is not written by a geologist; it is written by a geodesist;* but he dealt with some important questions from an entirely new point of view. He can be criticized in detail in many particulars, but we have only to read of the criticisms and discussions to which Wegener's hypothesis has given rise to realize the debt we owe him.

There have always been some people who have believed in great translations of continental masses. A namesake of mine, Sir John Evans, about sixty years ago suggested that the whole crust of the world might move so as to bring some countries under the North Pole and others under the Tropics; that then a further shift might occur and these positions reversed. Only a couple of years after his first paper, published, I believe, in the *Philosophical Transactions*, there was a small book by a cleric named John Kirk, which was certainly rather heterodoxic in many respects from the geological standpoint, but in it he suggested that the tropical climate of this country in the Eocene period was due to the fact that it then lay under the Tropics and that it had been shifted in the interval from the Tropics to the temperate region. A reviewer of this book, writing in the *Geological Magazine* in 1869, thought that he only had to state this proposition for it to be rejected with ridicule. But that is the very supposition which was brought forward by Dr. Staub in that wonderful book of his on the structure of the Alps. In that book you will find substantially what we have heard to-night; Dr. Staub goes very far in his ideas of the drift of continents. He says that Africa has been moved, roughly speaking, over 3000 miles to the north. As it moved it pushed Europe in front of it. Hence the fact that we are not enjoying a tropical climate at the present time. But in pushing Europe it badly smashed the south of that continent, and was driven over, as you have heard to-night, a great portion of Switzerland. The

* Perhaps I should have said a geophysicist, but he was, I believe, responsible for the topography of the expedition that traversed Greenland in 1912–13.

result, according to Dr. Staub, has been that there has been a contraction of the Earth's crust in Switzerland of something like 1000 miles. There are two kinds of drifting of continental masses: a drifting with the whole of the rest of the crust of the Earth, and a relative drift between the different continents. The general movement of the crust of the Earth over the interior is easier to explain than the movement of one portion of the crust relative to another, which involved the piling up of mountain ranges. Where did the force come from which produced it? Wegener rejects that due to the contraction of the Earth, but mathematicians tell us that it is the only force which is adequate to produce the result. But much smaller forces are capable of moving the whole crust of the Earth relative to the interior, and I see no reason why they should not be due to some of the minor causes which Wegener and others have suggested.

Col. Sir GERALD LENOX-CONYNGHAM: I had no intention, when I came here, of joining in this discussion, because I am no geologist, but I have just heard Dr. Evans say that Wegener is not a geologist but a geodesist. I do not think that we can accept him in the rank of geodesists. He has never written anything which gives serious geodetic support to his theory, and I thought geology was his special subject, because the foundation of his theory is mainly geological.

I should like to make one remark with reference to the most interesting lecture we have had from Professor Collet, namely, that I do not think that the isogamme chart of Professor Niethammer is secure evidence on which to base conclusions with regard to the underlying geology. I think, from the look of the chart, that the observations have not been reduced isostatically and that they are largely dependent upon the height of the different stations above sea-level. Until you have disentangled the results from the height above sea-level you cannot draw geological conclusions from them. I do not know whether Professor Collet will accept this criticism, but at present I feel that the chart does not allow one to draw geological conclusions.

The CHAIRMAN: I will ask Professor Collet to reply to the various remarks on his paper, and if there is any member present who has not had time to speak, if he will forward his remarks to the Secretary, they will be printed in the report of the proceedings in the *Journal*.

Professor LÉON W. COLLET: I quite agree with Sir Gerald Lenox-Conyngham. This map based on Niethammer's preliminary work has been published by Albert Heim in his well-known 'Geologie der Schweiz.' If I have shown it here, it is only to point out that the defects in gravity seem to correspond to the Pennine Alps and to the Austrian Alps, where we find the great recumbent folds formed into a geosyncline or on its southern border. Professor Niethammer has published, in 1921,* the results arrived at by reductions, in two maps, the one for

$$g_0'' - \gamma_0$$

and the other for

$$g - \gamma, \text{ with a depth of } 120 \text{ km.}$$

These maps show the same general features shown on the map I have here. If these results do not allow to draw geological conclusions, they are interesting from a geological and geographical point of view.

* Th. Niethammer, 'Die Schwerebestimmungen der Schweizerischen Geodaetischen Kommission und ihre Ergebnisse. Verhandl. der Schweizer. Naturforsch-Gesell. Schaffausen,' 1921, pp. 50-64.

Mr. Wordie seems to have another explanation for the formation of the geosyncline, if I understood him well?

Mr. J. M. WORDIE: I asked whether you could not imagine some other way of getting the space between the foreland and the hinterland instead of by pulling apart. Could you not, for instance, have bending down of the strata?

Professor LÉON W. COLLET: If the strata had been bent down, we should have to deal with a great thickness of Sial at the bottom of the geosyncline, which is against the geological evidences seen on the field. If, on the contrary, we suppose that the Sial was very thin, it is possible to understand how the basic magma has come into it. To explain this thin cover of Sial the best is to suppose that the foreland and the hinterland were pulled apart and the geosyncline formed between them.

Professor Argand has gone much further in using Wegener's ideas, but what I wanted to show you to-night is that we have in the Alps the evidence of a movement towards Europe. This movement seems to me to be a support of Wegener's theory. It is too late to go further into details. Those who are interested in this question might read the very valuable paper by Professor Argand on the tectonics of Asia.*

It has been a great pleasure to me to come here to speak about the Alps. I am always glad to be able to pay a "wee bit" of my debt of gratitude towards this country, for I owe the best of myself to British science.

The CHAIRMAN: If a child was taken to the mountains the first question asked would be: "How are mountains made?" Well, I think we grown-up children have all been thinking about that, even earlier than Professor Collet suggested; in fact, since the days of Leonardo da Vinci, who, if he did not go very far, made interesting speculations with regard to the Alps. To-night, whether the experts thoroughly agree with all that has been said or not, we shall all agree in feeling that we have seen a step forward taken; that we have had proof that our generation is doing its share, and more, in elucidating this great problem. We shall also agree in hailing Professor Collet as one of the most distinguished of the pioneers in this branch of science. We have a feeling of very great gratitude to him for having come over at this season of the year—we only wish he had brought a little of Africa with him—to our bleak climate, which has long been moved north from the Tropics, to talk to us. We wish him a very happy return to his own country, where England is always liked and Englishmen, as I know from personal experience, are received with the utmost kindness. I ask you to give a hearty round of applause to Professor Collet for his lecture.

THE GEOGRAPHICAL DISTRIBUTION OF PLANTS IN RELATION TO CLIMATIC FACTORS

E. J. Salisbury, D.Sc., F.L.S. (Reader in Plant Ecology in the University of London)

THE subject with which it is my task to deal is one aspect of the study of plant ecology: a science which, though it may be said to have its foundations in the observations of Humboldt ('De distributione

* E. Argand, "La Tectonique de l'Asie," C. R. Congrès Géologique International Belgique, 1922.

geographica plantarum,' Paris, 1877), if not in those much earlier of Nearchus, the admiral of Alexander the Great, is nevertheless still in its infancy. Ecological plant geography may, from one aspect at least, be regarded as a particular branch of applied physiology in which we consider the reaction of species (autecology) or plant communities (synecology) to the numerous variable factors of their particular environments. Whilst however the plant physiologist concerns himself, for example, with the conditions that initiate and control growth, with the optimal and limiting temperatures for this process, its relation to water supply, etc., the ecologist, though he should be cognizant with all that the physiologist can teach him as to the relations between function and environment, is primarily concerned with these as they affect the capacity of the individual species or individual plant community to maintain itself in the struggle for supremacy against others. Thus what on first consideration might appear to be a physiological problem is apprehended as something more. The points of view of the geographer and the ecologist are alike bound up with the conception of competition, and for them *the importance of conditions which affect an organism in relation to others is thus directly proportional to the extent of their selective action.*

Climatic conditions which a plant can endure, which even enable it to carry out its customary life-history, may be quite inadequate to confer such vigour as will enable it to produce offspring in sufficient numbers to withstand the normal agencies of depletion. On the other hand, the occurrence of a certain species in what might perhaps be regarded as a slum of the plant world, may be correlated with the better endurance of an adverse condition which whilst depressing the vigour of this species nevertheless favours it by the elimination of others. There is consequently, with regard to any geographical factor, a border zone of greater or less width where the balance of the struggle between species is sufficiently even as to be profoundly influenced by conditions which in the centre of their ranges would play little, if any, part in determining their distribution. So the extreme limits of range for species or types of plant community often correspond not to any single factor but to a complex of conditions that can only be analyzed after detailed investigation to which the ecologist, the plant physiologist, and the geographer can all contribute. At this point we may appropriately call attention to the need for maps which, in addition to showing the area of distribution of a species, show also its abundance and frequency of occurrence. It is also much to be deplored that such terms as "rare," "common," "occasional," etc., have been used in several senses—sometimes to connote the abundance of individuals, sometimes the frequency of occurrence within an area, sometimes even the area itself relative to the region examined. In our own flora some species are rare in all senses, as for example *Cotoneaster vulgaris* (Plate 1), represented by one or two individuals con-

fined to the Great Orme's Head. But the Lizard Orchid (*Himantoglossum hircinum*) is rare in another way. Its area extends from Somerset in the west to Norfolk and Kent in the east, but the number of individuals in any one locality is always small. Still another kind of rarity is exhibited by the Dorset Heath *Erica ciliaris*, which is locally abundant. It would clarify distributional data considerably if such terms as "rare" and "common" could be confined to indicating abundance, with the prefix local where the distribution is restricted, and in its absence a general distribution could be assumed. Always, however, there will remain the difficulty that a given status of abundance cannot mean the same occupation of the Earth's surface when applied to totally unlike species (*e.g.* solitary and social species). Contrast, for instance, the Tutsan (*Hypericum androsæmum*), which, though occupying a wide southern range, generally occurs as isolated specimens, with its congener the St. John's Wort (*Hypericum perforatum*), of which hundreds or thousands of individuals may occur together in a coppiced wood.

The direct influence of temperature when it approaches the extremes of heat or cold is so obvious as to need no emphasis. Ultimately resistance to extreme heat must depend on the capacity of the protoplasm to remain uncoagulated, whilst the resistance to intense frost will depend on resistance both to the precipitation of the proteins and also to formation of ice crystals that would rupture the living protoplast. Actually the capacity of certain organisms to withstand extremes of temperature is surprising. *Larix sibirica* occurs where the winter temperature may attain nearly −70° C., whilst *Cyanophyceæ* occur in hot springs where the temperature of the water attains over 80° C., and one member of that group, *Phormidium laminosum*, has been found in a living condition in water at a temperature of 87°·5 C. It is clear that in such extreme cases the protoplasmic constitution must be markedly different from that of most plants to admit of such high temperatures without precipitation of the proteins. V. Vouk, who has recently investigated the biology of these hot springs (*Int. Rev. Ges. Hydrob. u. Hydrog.*, pp. 89–99, 1923), finds that only *Phormidium laminosum* and *Mastigocladus laminosus* occur in water of a temperature above 49° C., whilst below this temperature a number of other species of blue-green algæ are also present. Such a wide temperature interval, viz. 38°·5 C., between the limit for the majority of the species of these hot springs and the limit for those which endure the highest temperatures supports the view that there is a fundamental distinction in the colloidal protein complex. In any case the fact of this wide temperature interval between closely allied species is certainly not what we should expect if the capacity for the endurance of high temperatures had been acquired by a gradual process of acclimatization, a subject to which we shall have to revert.

Resistance to heat and cold is well known to be roughly in inverse proportion to the amount of water which the plant or part of the plant

contains. Hence the familiar fact that young twigs of fruit trees suffer from frost when the older wood with its lower water content survives. As the season advances the new twigs exhibit a decreased water content and increased hardiness, so that early frosts are more harmful than late frosts. Recently R. B. Harvey (*Jour. Agr. Res.*, pp. 83–112, 1918) has shown that a low temperature for a few days prior to actual frost may induce a higher hydrogen-ion concentration in the cells and a higher salt content, both of which tend to prevent coagulation of the protoplasm; but the investigations of H. D. Hooker on apple shoots (*Proc. Amer. Soc. Hort. Sci.*, 17, pp. 204–207, 1921) and of J. T. Rosa on various cultivated vegetables (*ibid.*, pp. 207–210) would appear to indicate an association of hardiness with the content of pentosans which these authors suggest are important as retainers of adsorbed water. From an examination of fruit trees over a large area after severe frost, W. A. Chandler found (*Proc. Amer. Soc. Hort. Sci.*, pp. 18–24, 1919) that old trees, and trees which had fruited heavily the previous season, were killed, whilst young trees and those which had not fruited heavily survived. Such facts show that direct injury and death from frost is not a simple relation, but that the effect of low temperatures is modified by internal factors as well as by the rate of the temperature change. Examples of the direct influence of temperature in limiting the geographical distribution of species are afforded by the cacti among terrestrial plants, and, amongst aquatic plants, by many marine algæ. The former have been studied by Uphof (cf. *Jour. Ecology*, p. 41, 1920), who states that "The vertical distribution of cacti depends entirely on the minimum temperature in winter." The giant cactus, *Carnegia gigantea*, has a very restricted distribution in South-Western Arizona, almost coextensive as to its northern limits with an area in which the minimum temperature rarely falls below −10° C. That its altitudinal limit at 1500 metres is determined by the same factor is shown by the mortality amongst the young plants at this height during severe frost (*loc. cit.*, p. 42). W. A. Setchell ("The Temperature Interval in the Geographical Distribution of Marine Algæ," *Science*, pp. 188–190, 1920) has drawn attention to the limited temperature range of marine algæ, the seasonal amplitude of which for single species is under 10° C. As a consequence their zonation corresponds closely with the isotherms of the surface water.

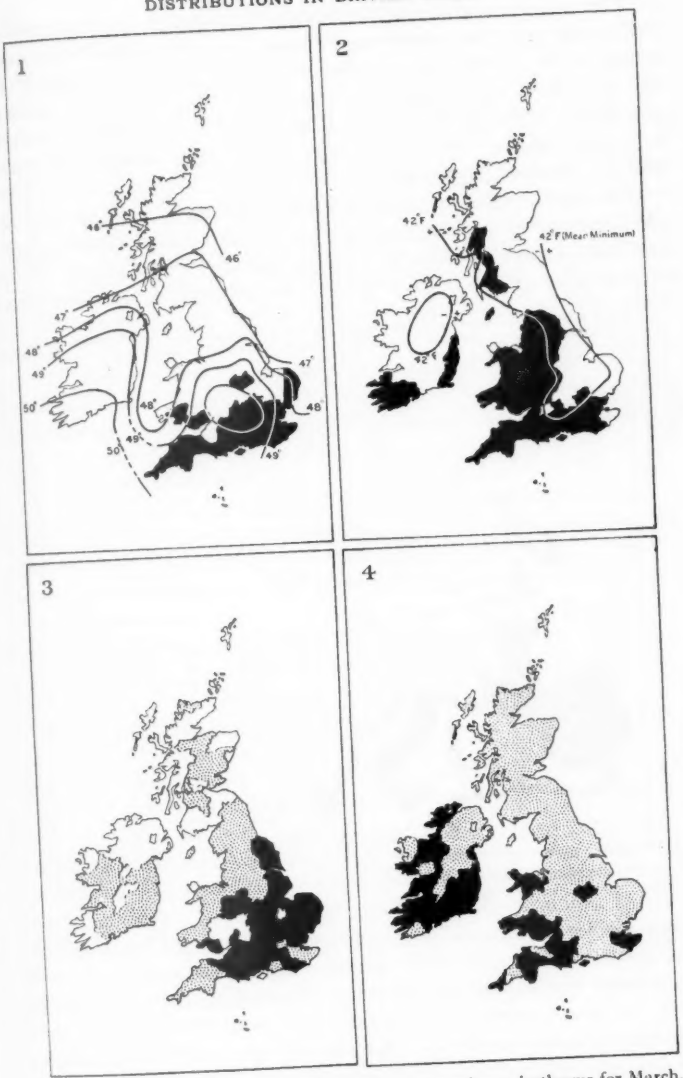
Much more commonly the limits in relation to temperature are due to the indirect effect of this factor on the water relations of the plant, bringing about death from excessive transpiration. Thus the physiological drought resulting from the freezing of the soil at low temperatures does not necessarily cause the death of a coniferous tree unless the frost be accompanied by bright sunshine and wind, which promote a loss of water from the foliage that cannot be made good by root absorption.

We are all familiar with the fact that trees and shrubs flourish under conditions of cultivation in regions of the Earth where they do not occur

as wild species. Occasionally the extensive reproduction and spread of such introductions, as in the case of the Sycamore and the common Rhododendron (*R. ponticum*) in Britain, serve to demonstrate that their absence from the indigenous flora of an area is not due to any climatic barrier. But in most cases the absence of fertile seed or of adequate germination can often be correlated with the unsuitablity of the meteorological conditions in their new home. Controlled experiments have shown that for several species, and probably for the majority, the temperature which produces the greatest vegetative vigour is appreciably lower than that at which the species will flower most profusely, and an even higher temperature is required to procure the optimum conditions with respect to seed production. Hence many species when cultivated beyond their geographical limits exhibit great vigour, but their capacity to become constituents of the unprotected flora is limited by their inability to flower and fruit. If, however, the species is capable of extensive vegetative production its geographical range becomes proportionately increased. Thus the Lesser Celandine (*Ficaria verna*) which reproduces freely by seed in the southern part of its area, reproduces almost exclusively by vegetative means towards its northern limit. In this country the production of fertile seed is appreciably greater in those years when the spring temperatures are high. Not only has climate a differential effect upon the various phases of a plant's activity, but sometimes also on the sexes of unisexual species. A striking instance of this is afforded by the Water Soldier (*Stratiotes aloides*), whose geographical area forms a belt across Central Europe. South of 52° N. only the male plant usually occurs, though the female plant is occasionally found in Eastern Europe south of this. Towards its northern limit between 55° and 68° N. the female plant is alone found, as also in this country. In the middle region the two sexes intermingle, and in this area reproduction by seed consequently takes place. It is thus apparent that the effect of temperature in limiting the range of a species may be profoundly modified by the presence or absence of a vegetative mode of propagation or by its efficiency. Further, if the temperature interval between the optima for the processes of growth and reproduction be large, the geographical limitation from this cause will tend to be ill defined and liable to modification by other factors of the environment.

In our own flora the direct influence of temperature is well shown by some of our southern types. The Butchers' Broom (*Ruscus aculeatus*), for example, whose temperature relations are sufficiently emphasized by its restriction to the southern counties of England (Fig. 1), although flowering with some freedom rarely produces fertile seeds near its northern limit except in hot summers. Its general rarity can therefore probably be attributed to the consequent infrequency of regeneration. Incidentally, too, this species illustrates how the maintenance of a plant in nature may depend on the periodic occurrence of exceptional conditions.

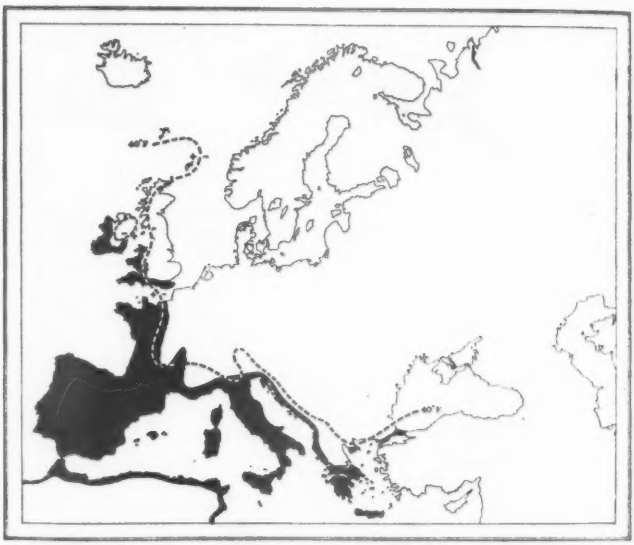
DISTRIBUTIONS IN BRITISH ISLES



1. *Ruscus aculeatus* (Butchers' broom) and mean maximum isotherms for March.
2. *Wahlenbergia hederacea* (Ivy-leaved bell-flower).
3. *Centaurea scabiosa* (Greater Centaury), host, and *Orobanche elatior* (Greater Broomrape), parasite.
4. *Hedera helix* (Ivy), host, and *Orobanche hederæ*, parasite.

The Madder (*Rubia peregrina*) affords an example of a species whose British and European distribution shows a northern limit which corresponds fairly closely with the mean January isotherm of 40° F. (cf. Fig. 5). It is significant that in this month *Rubia* is just forming its new shoots, whilst the distribution of *Ruscus* (cf. Fig. 1) shows a tendency to occupy regions where the temperature in the month of flowering exhibits relatively high maxima.

The distribution of a southern species towards its northern boundary can be regarded as presenting three zones in relation to temperature. The central area in which the temperature normally suffices not only for vegetative growth but for reproduction adequate to the maintenance



5. Distribution of *Rubia peregrina* (Madder) and January Isotherm 40° F. (Continental distribution after Stapf.)

of the species in undiminished numbers. This region represents the area of maximum density of the species. Beyond is a zone in which the temperature is adequate for vegetative growth but only in exceptional years for reproduction. In this zone the species if possessed of no specialized mechanism of vegetative reproduction will be comparatively rare, and the width of the zone itself will be to some extent dependent on the length of the life of the individual plant and the frequency of exceptional hot seasons. Beyond this zone is the zone of cultivation reaching to the temperature limits determined by the protoplasmic constitution of the species, and within which it can only be maintained by artificial aids to regeneration.

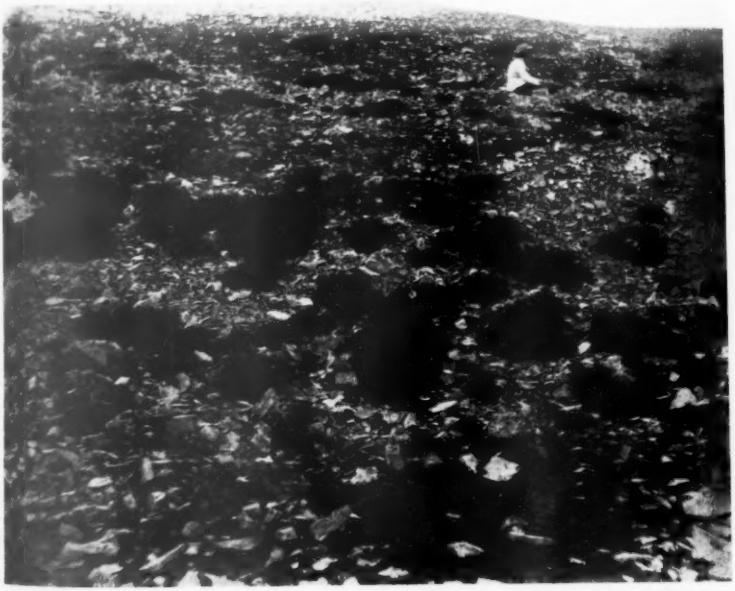
One of the most important climatic features associated with temperature is the length of the vegetative season or frostless period, and the distribution of certain biological types, such as coniferous evergreen trees, broad-leaved evergreen trees, and deciduous trees, is fairly definitely related to this factor. If we fix our attention on lowland forests in the tropical and sub-tropical regions characterized by the absence of any season which through low precipitation or low temperature is definitely unfavourable to growth, we find that the forests are dominated by broad-leaved evergreen trees. If there is a marked climatic periodicity, whether it be the alternation between summer and winter of the temperate regions, or between wet and dry seasons, as in the sub-tropical, the forests are mainly composed of deciduous trees which by shedding their leaves maintain the balance between water absorption and water loss. As we pass northwards where the unfavourable cold season is very prolonged, the broad-leaved deciduous trees are replaced by forests of narrow-leaved evergreen conifers. The evergreen habit is clearly advantageous where the growing season is very short, since no part of the all-too-restricted period during which the temperature is high enough for active assimilation is squandered in the production of a new canopy of foliage. The similar zonation which is encountered on many mountain slopes led the earlier plant geographers to postulate a closer relationship between the latitudinal and altitudinal zones of vegetation than actually exists. Nevertheless, the widespread occurrence of the coniferous forest occupying the upper margin of the timber belt where the season is of short duration, is the more impressive by reason of the many diverse species of which this belt is composed. In Switzerland we have the familiar transition from the beech woods below to the forests of spruce and fir above, where the snow-free period is of between five and six months' duration. In Arizona the woods of evergreen oaks (4300–6300) are succeeded by coniferous forest of fir or spruce up to 7500 feet, where the vegetative season is from four and a half to seven months. Similarly in the Himalayas coniferous forests, which, Professor Troup informs me, consist chiefly of *Abies* and *Juniperus*, occur above the belt of broad-leaved trees, but if the mountains of an area be low in relation to the latitude the forests of broad-leaved trees may extend to the timber-line, as in Wales, where the latter is reached at about 1200 feet, and Kurdistan, where the tree limit is situated at about 600 feet (cf. H. Handel-Mazzetti, *Ann. Nat. Hofm. Wien*, pp. 48–111, 1914).

But even in respect to a biological type so obviously fitted for periodic climatic conditions as the deciduous tree other factors may be involved. Thus the occurrence of a number of deciduous trees of Asiatic affinity in Brazil in a region where the majority of the trees are non-periodic and the climatic conditions are relatively uniform, has led H. von Ihering to assume their immigration in Tertiary times from an area characterized by a dry season and the retention of the deciduous habit as an hereditary

trait long after its necessity had been left behind (ref. *Bot. Jahrb.*, pp. 524–598, 1923). In this connection mention may be made of the evergreen habit assumed by the common Oak (*Quercus robur*) in Jamaica, whereas the Tulip Tree (*Liriodendron tulipifera*), which has also been introduced, has retained its deciduous habit (cf. F. Shreve, *Carnegie Publ.*, 199, 1914). That the individuality of the organism is as important as the external conditions is not only shown by such absence of harmony between the periodicity of the plant and the climatic conditions, but also by the frequent association of continuous or periodic leaf production with continuous or periodic flower formation. This relation, according to Coster (*Ann. Jard. Bot. Buitenzorg*, **33**, pp. 117–190, 1923), is general in East Java, where there is a five-months' dry season (July to October) and a rainy season from December to April. In spite of this marked periodicity some species of trees grow continuously (*e.g. Artocarpus communis*, *Ficus septica*), whilst others have a resting period that is not coincident with the unfavourable period (*e.g. Pithecolobium umbellatum*). The historic factor must be again invoked to explain the occurrence of ephemeral species as weeds of arable land where the necessity of so abbreviated a life-history no longer obtains. Brevity of the growing season is responsible for the elimination of annuals from arctic regions and mountain summits. Thus Ostenfeld (*Meddel. Grönland*, **64**, pp. 233–268, 1923) found seventy species of vascular plants north of 82° N. lat. in Greenland, which were exclusively perennial. We have already referred to the effect of abundant fruiting of trees in reducing their resistance to frost, a factor which may well be responsible for the death of many annual species. If the latter be artificially prevented from fruiting they will often persist into a second season, and a few instances are known where arctic conditions produce the same result naturally. For example, the annual *Arenaria serpyllifolia* behaves as a perennial in arctic and alpine situations, but such plasticity is of rare occurrence.

We see then that even when temperature plays the rôle of a master factor its effect will be very different according to the habit and life-history of the species. The Danish ecologist Raunkaier has elaborated a classification of biological types based on the degree of protection (or exposure) of the resting buds, and analyses of the floras of various regions show that they are often characterized by a preponderance or deficiency in certain types. For example, herbaceous species which have their resting buds in the surface soil comprise nearly 60 per cent. of the flowering plants of cold regions such as Spitsbergen and Alaska, whereas in the Danish West Indies such comprise only 9 per cent. Or again, whereas the flora of the Libyan desert contains 42 per cent. of annuals, that of Spitsbergen contains but 2 per cent. and that of Alaska only 1 per cent. Similarly, the proportion of herbaceous species increases with increasing altitudes, whilst the percentage of annual plants decreases. The high percentage of annuals in deserts is perhaps related rather to

1. COTONEASTER VULGARIS ON MOUNTAIN LIMESTONE



2. MAT-LIKE PRUNUS SPINOSA (BLACKTHORN) RESULTING FROM WIND-TRIMMING

3. PHRAGMITES COMMUNIS (COMMON REED) AS A SALT-MARSH PLANT

4. TREE LIMIT, SCRUB ZONE AND ALPINE PASTURE, MOEL WNION

the open character of the plant community than to the climatic conditions, since the same feature is found in open communities of temperate regions (*e.g.* the Corynephoretum of the Paris Basin exhibits 53 per cent of annual species). Low-growing plants whose buds are situated on or just above the soil (*Chamæphytes*) are especially characteristic of northern latitudes, and that these variations in the proportions of the different biological types are related to temperature seems indicated by the fact that zones based on equal percentage frequencies of Chamæphytes approximate in their course to the isothermic lines (cf. C. Raunakier, *Bot. Tidsskr.*, 29, pp. 42–83, 1908; and *Beih. Bot. Centralbl.*, 27, pp. 171–206, 1910). The fact that whereas the Arctic regions support some 400 species of flowering plants whilst in the Antarctic there are only two is probably due, as Rudmose Brown has suggested, to the fact that the mean temperature of the warmest month in the South Orkneys (60° 44′ S.) is below freezing, whereas in Spitsbergen (79° 53′ N.) the corresponding mean is 41°·5 F. ('Scottish Nat. Antarctic Exped.,' vol. 3, Bot.; 1912). The dominance of mosses in the Antarctic (over 50 species are known to occur) is in conformity with the marked resistance to cold of the members of this group, probably due to their capacity for developing a high osmotic pressure (cf. Irmscher, *e. Fahrb. F. Wiss. Bot.*, pp. 387–449, 1912). The data available for the United States respecting the length of the frostless season (cf. Day, *U.S. Dept. Agr. Weather Bur.*, Bull. 5, 1911; and Livingston and Shreve, *Carnegie Publ.*, 284, Map 34, 1921) show that the equiseasonal lines are deflected northwards as they approach the coasts and in the neighbourhood of the Great Lakes, and Livingston and Shreve call attention to the fact that their chart indicates a tendency for the growing season to lengthen in the neighbourhood of the larger rivers. The restriction of many southern species to the coastal zone of Connecticut is explained by Nicholls (*Bot. Gaz.*, 1913, pp. 143–152) as due to the fact that here the growing season is prolonged twenty-nine days as compared with that inland, and the same feature is met with in relation to our own shores. 34 per cent. of the littoral species of vascular plants in the British Flora have a southern distribution on the European continent, and some of these are definitely Mediterranean (*e.g. Statice reticulata*). But of the non-littoral flora the southern element comprises only 7·5 per cent. of the total.

It is in conformity with this influence of the oceanic conditions towards an extension of the growing season that the boreal limits of deciduous trees in Europe reach their maximum northward extension near the west coast. The common oak, for example, attains to 63° N. on the coast of Norway, whilst in Siberia its northern limit is much further south (cf. Fig. 10). Brockman has pointed out that the actual tree limit is depressed in the regions possessing an oceanic climate and attains its maximum polar extension in the continental area. In Siberia, for instance, the tree limit attains 72° 40′ N. lat., whilst in the Aleutian Islands

it only attains 50° N. lat., Prof. Brockman attributes this to the greater temperature amplitude in continental areas as a consequence of which a higher temperature is attained during the growing season than in oceanic regions. It may, however, be questioned whether the higher average wind velocity in oceanic areas may not play a larger part than he supposes in the displacement of the tree limit in the equatorial direction in the oceanic regions of the Northern Hemisphere, and in the Southern Hemisphere generally. The inimical effect of wind on tree growth is sufficiently well known, and it is significant that the greatest equatorial displacement of the tree limit in the Southern Hemisphere is in the islands situated in the "Roaring Forties." The tree limit on mountains is determined by similar conditions, and it is a noteworthy feature that both in Switzerland and in America it has been found that the larger the mountain mass and the higher the mountain, the greater the altitude which the tree limit attains (cf. Schroeter, *Pflanzeleben der Alpen;* and P. A. Rydberg, *Bull. Torrey Bot. Club*, pp. 677–686, 1913). The same feature is illustrated by the upper limits of herbaceous species, and is well shown in the case of the widespread Alpine Persicaria (*Polygonum viviparum*). This species attains 14,500 feet on Mount Everest; on Mont Blanc its upper limit is 10,400 feet, and on Ben Nevis 4000 feet. If we adjust the differences in altitude of the mountains and of the respective limits for *P. viviparum* in accordance with the differences in latitude, it will be realized that the limit tends to be higher on the larger as compared with smaller mountains. Brockman again attributes this feature to the more continental character of the climatic conditions on larger mountains, but here too it is not improbable that exposure factors are largely responsible. Exposure certainly appears to determine the dominance of Birch at the limit of woodland in Wales, and the transition zone of scrub between the Birch wood and Alpine pasture (Plate 4).

The tree limit on mountains is also profoundly modified by the effect of topography on cold-air drainage and by aspect. The effect of the former on distribution has been shown by Forest Shreve ('Plant World,' pp. 110–115, 1912), who found that cold-air drainage might cause a reversal of the normal temperature gradient associated with differences in altitude. In one instance investigated the effect was to produce minimum temperatures in a valley which were only realized on the adjacent ridges at an altitude of some 2300 feet higher. In the Alps the limits for the dominant species are often raised from 150 to 200 metres on the southern slopes as compared with the northern, and the effect of topography in producing sheltered sunny spots may considerably extend the potential range of a species. In this connection we may recall the observation of Blytt (*Englers. Jahrb.*, 1893) that southern species occur near Oslo at the foot of rock faces having a southern aspect.

R. Sterner's analysis of the continental element in the flora of Sweden (*Geografiska Annaler*, H. 3–4, 1922) has shown that its occurrence is

rendered possible by the dry character of the soil and the southern aspect of the slopes on which the continental species are found. In our own flora the continental element is centred in the Breckland area of Suffolk, and there can be little doubt that the dry well-drained character of the soil of these sandy heaths is the chief factor which determines the presence of such species as *Veronica spicata*, *Artemisia campestris*, *Scleranthus perennis*, etc., here and not in adjacent parts of the same area of low rainfall. So, too, the effect of soil on climate is seen in the fact that the altitudinal limit of several species in the Alps rises on the calcareous soils.

Our brief review of a few of the features which determine the relation of species to temperature serves to impress us with its complexity. Even though the temperature be the master factor, we have seen that its influence may be modified by the reaction of the plant itself, by changes in topography, by differences in the character of the soil, by the effect of competition, etc. It is therefore not remarkable that the limits of species susceptible to temperature changes often show but little relation to isoclimatic lines; rather is it surprising that the correspondence is sometimes so close. Further, it must be emphasized that the available data are often inadequate to demonstrate the relationship even if it exists, and a thorough knowledge of the biology of the species is essential before one can determine whether it is one or other extreme of temperature, an extreme at some particular critical season, a summation of temperatures or some other data that are essential to demonstrate the relation.

It is perhaps almost unnecessary to add that the mere correspondence of the limits of distribution of a species or community with isothermal lines, or any other climatic limits, is at the best presumptive evidence and no proof of any causal connection between them. But it is evident that a wide range is indicative of high plasticity, and hence, as Lutz has shown (*Bull. Amer. Museum Nat. Hist.*, pp. 335–366, 1922), there is a high correlation between the east-and-west extent of species and their north-and-south range. Moreover the hardier northern species have in general a more extended range than southern types.

Precipitation constitutes perhaps the most important climatic factor affecting the geographical distribution of species. It is a familiar fact that in equivalent latitudes the chief types of vegetation correspond roughly to the amount of the annual rainfall. It is generally true that the areas occupied by forest are those in which the rainfall is highest, that areas of lowest rainfall are occupied by desert, and those of intermediate rainfall by grassland. Thus in the United States the mean annual rainfall in the regions of desert is 0–30 inches, in the prairies 20–30 inches, and in the forest regions 30–90 inches. But though the total annual rainfall may be important in determining the geographical distribution of certain species, the occurrence of most is as much dependent on the seasonal distribution of the rainfall as upon its total

amount. Forests can maintain themselves even in areas of relatively low rainfall, provided this is distributed with sufficient uniformity to ensure the absence of long drought. Even in the hot climate of North Africa forests of *Pinus Halipensis* and *Cedrus Atlantica* occur where the mean annual rainfall is under 28 inches (700 mm.), but fairly evenly distributed throughout the year. On the other hand, prolonged drought is fatal to trees, although herbaceous vegetation may flourish. Thus the scarcity of woody perennials in the Tibetan marches, where there is a rich herbaceous flora, is attributed by Kingdon Ward to the droughts in the warm and cold seasons (cf. *Jour. R.H.S.*, pp. 201–212, 1923). The importance of the seasonal distribution of rainfall is nowhere more pronounced than in deserts where the chief feature of the vegetation is the large proportion of annuals that pass through their life-histories in the space of a few weeks and survive the drought period by means of seeds. The brief life-cycle of these desert annuals is compassed in the period of maximum rainfall, and in the Sonora desert of America, where two rainy periods occur, annuals appear in both, though most of the species are distinct. Again, as Warming pointed out, the Steppe vegetation of Russia is not conditioned so much by insufficient rainfall as by the co-incidence of the period of maximum precipitation with that of intense evaporation. It is to be regretted in this connection that detailed maps showing the seasonal distribution of rainfall are not available, and the plant geographer can echo the plea of Mr. Ogilvy for maps showing the actual rainfall not reduced to mean sea-level.

Precipitation is effective only in so far as it supplies moisture to the soil which the roots of the plants can absorb, and, by rendering the air humid, slows down the rate of water loss from vegetation. The point at which a plant becomes permanently wilted is determined on the one hand by the rate at which its surface is losing water, and on the other by the rate at which this deficiency can be made good. The limit to which the water content of the soil can be reduced by the plant is mainly dependent on the soil texture and the atmospheric conditions under which the plant is losing water. Wilting ensues not because the roots have failed to absorb, but because the rate at which they absorb falls below that at which water is being given off by the foliage. It is thus in large part conditioned by the evaporating power of the air as it affects the transpiration of the plant, and still more by the resistance which the soil texture offers to the flow of water from the moister to the drier regions around the roots. The efficiency of a particular rainfall may thus be profoundly influenced by soil structure. Dark soils, by absorbing a large amount of radiant energy, become strongly heated, and thus increase the evaporation of rain which falls upon them (*e.g.* loess soils, which may have a temperature of 17° C. higher than light-coloured soils). So, too, the facility for percolation in hot climates profoundly modifies the effect of a particular rainfall. The rainfall efficiency is likewise

impaired by wind and high temperatures, which increase the evaporation from the soil and the rate of transpiration from the plant. Since the velocity of wind increases with the height above the ground, it is not surprising that low-growing vegetation may flourish where tree growth is inhibited. In the Alps the prostrate form of *Pinus Montana* attains to a much higher altitude than is possible for the normal type, and this is true also of the Blackthorn in this country (Plate 2). The difficulty of establishing plantations of trees on exposed mountain slopes, where they flourish subsequent to the creation of a wind-break, is experimental proof of the inhibiting effect of wind on the tree growth. On a grand scale the absence of trees from Anglesey, where in Roman times there were forests, since destroyed by man, is evidence of the importance of human agency in abetting climatic factors. There is some evidence, too, that man has been responsible in the past for the large treeless tracts of prairie in America, or of grassveld in South Africa. Colonization of the latter by trees takes place when the grassveld is protected from fire, and through the shelter of the pioneer Acacias the woody vegetation gradually extends. The cold winds of Arctic regions inhibit tree growth not merely by reason of the increased transpiration from the plants, but also because the consequent cooling of the soil simultaneously diminishes the rate of absorption by the roots. The treeless tundra appears to be approximately co-extensive with the areas in which the prevailing winds are cold and of a velocity greater than 6 m. per sec. at a height of 10 metres above the ground-level (Szymkiewiez, *Acta Soc. Bot. Polon.*, 11, 2, 1924); whilst in the Andes of the Argentine the absence of trees and the dominance of low-growing rosette and cushion plants at altitudes between 6,500 feet and 13,650 feet are associated with constant winds of high velocity (cf. L. Hauman, *Anales Soc. Cien. Argentina*, 86, pp. 121–188, 1918).

The capacity of a species to withstand drought will depend in great measure on the resistance it can offer to water loss on the one hand, and its capacity to withdraw moisture from the soil on the other. Transpiration checks, such as a thick cuticle, sunken stomata, hairiness of the leaf, massing of the foliage, etc., vary within certain limits as between individuals of the same species. Like economies in expenditure of money, they enable the individual to subsist on a diminished income.

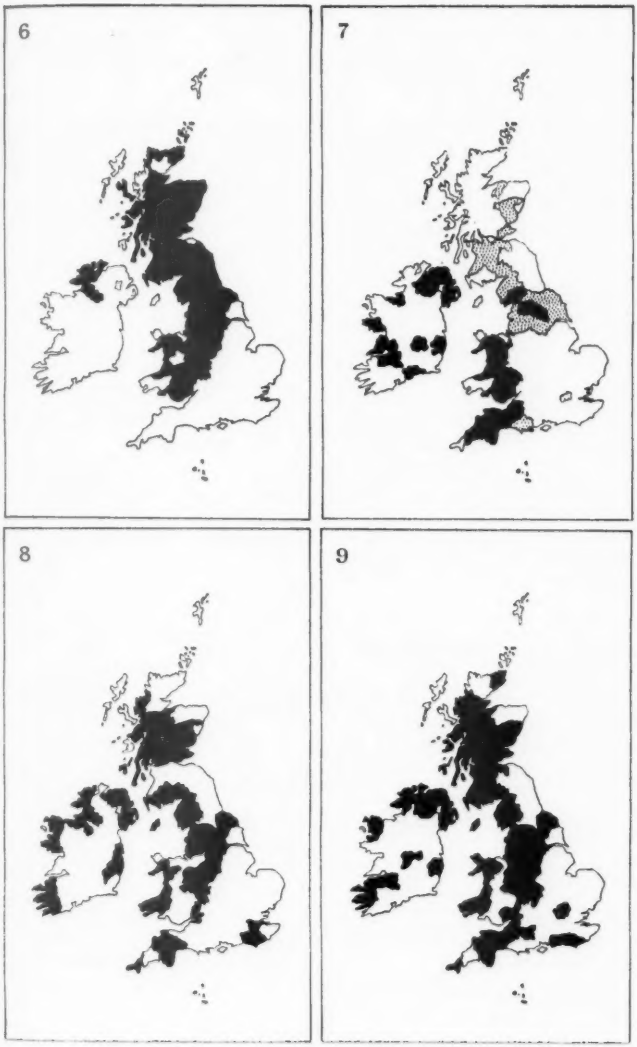
The well-known fact that some species are glabrous in a humid environment but become hairy when grown in a dry atmosphere is but one example of a plasticity which, though limited as to range for a particular species or geographical race, materially affects the diversity of conditions that the species can endure.

On the credit side the plant can increase its water-income b an increase in the extent of the root system, thus exploiting a larger volume of soil, and by raising the osmotic pressure of its cells upon which the suction force exerted by the roots depends. The concentrated character

of the soil solution in the salt deserts of Turkestan or the " Bad Lands " of America would render plant-life impossible were it not for the high osmotic pressures which the succulents of these regions are capable of developing. The highest value recorded is for *Atriplex confertifolia* (*Proc. Soc. Exp. Biol. Med.*, pp. 106–109, 1921), where a suction force equivalent to 153 atmospheres can be developed. The average osmotic pressure of plants of the Jamaican " Rain Forest " is 11·44 atms., whereas that of the plants of the Arizona desert is nearly 30 atms. Most plants are capable of considerable adjustment in this respect, and exhibit an increase of osmotic pressure in wind and at high temperatures, whilst there is a decrease when either the water content of the soil or the humidity of the air increases (cf. *B. d. Deut. Bot. Ges.*, 34, pp. 123–142, 1916; and *Jour. Ecology*, p. 160, 1916), yet it is only certain species which are potentially capable of developing a suction force such as will enable them to occupy desert regions. The almost cosmopolitan distribution of the Common Reed (*Phragmites communis*) is doubtless in part attributable to its marked plasticity, and in no direction is this more evident than in its capacity to grow not only in water, where the soil solution is extremely dilute, but also as a dwarf form in salt marshes on our own coast (cf. Plate 3), or, as Paulsen records, in the salt deserts of Transcaspia ('Vegetation of the Transcaspian Lowlands,' p. 52 : Copenhagen, 1912).

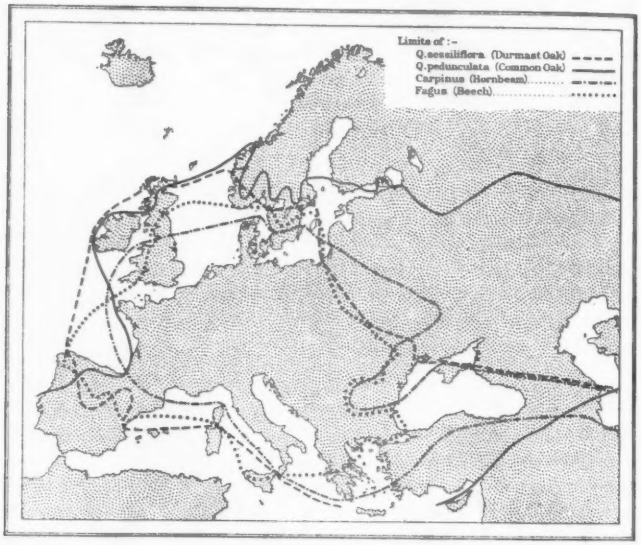
The volume of soil which the root-system exploits is not directly related to the available supply of water, but is dependent on such factors as soil aëration and the depth of percolation of the rainfall. Weaver found that in regions of similar soil character but differing in regard to the annual precipitation, the roots of winter Wheat were shallowest where the annual precipitation was least (*Amer. Jour. Bot.*, vol. 12, p. 504, 1925). Nevertheless the faculty of developing roots to a depth of 40 feet possessed by some Acacias is of great importance for their maintenance in desert conditions, where they subsist on subsoil water.

In consequence of such plasticity and adaptation the ranges of plants with respect to precipitation are often no more clearly defined than with respect to temperature, and not uncommonly it is only the frequency distribution in relation to this factor that indicates its importance. But apart from the chief types of vegetation there are some species whose areas appear to be closely connected with rainfall and humidity. In the British flora the Welsh Poppy (*Meconopsis cambrica*) (Fig. 7), the Wood Vetch (*Vicia sylvatica*), and the Globe Flower (*Trollius europæus*) (Fig. 6) are absent from the drier parts of Eastern Britain, although present throughout the west. Striking examples are furnished by some of the Liverworts (*e.g. Bazzania trilobata*, *Trichocolea tomentella*) (Figs. 8 and 9) and the distribution of two of the parasitic Broomrapes are of interest in this connection. From the nature of their nutrition it is obvious that soil factors can play but little part in influencing the distribution of parasitic plants, and in the



6. *Trollius europæus* (Globe flower).
7. *Meconopsis cambrica* (Welsh poppy): light shading, introduced.
8. *Bazzania trilobata* (Liverwort).
9. *Trichocolea tomentella* (Liverwort).

two species under consideration the host plants occur throughout England and in most parts of Scotland and Ireland; yet the one, *Orobanche Hederæ*, which is found on the ivy, is restricted to the west (Fig. 4), whilst *O. elatior*, which is parasitic on the Great Knapweed (*C. scabiosa*), is confined to the east (Fig. 3). This example is the more important as it is exempt from the criticism that the drier parts of Britain are also the more intensively cultivated and more densely populated areas. The absence of both these Broomrapes from Scotland is probably a temperature effect, and the combined influence of this factor with humidity and rainfall probably explains the peculiar distribution of the Ivy-leaved Bell Flower (*Wahlenbergia hederacea*) (Fig. 2).



10. Distribution of Oaks, Beech, and Hornbeam.

The distribution of the Beech tree, which is very intolerant of water-logged soils, illustrates the modifying influence of soil texture on the effect of precipitation. In the dry continental climate of Central Europe this species occurs on a great variety of soils, whereas in the oceanic climate of Britain and Denmark the beech is confined to well-drained soils such as chalk and deep sands. It is indeed probable that many of our so-called calcicole species exhibit a preference for calcareous soils more by reason of their physical properties than because of their chemical characteristics (cf. Salisbury, "Significance of the Calcicole Habit," *Jour. Ecology*, pp. 202–215, 1920). The presence of some species, which normally occur in damp habitats, on the apparently dry ridges of

dunes (*e.g. Epipactis palustris*) and shingle beaches (*e.g. Polygonum amphibium*) is perhaps rendered possible by the peculiar interaction of soil structure and climatic conditions known as internal dew formation (cf. Olsson-Seffer, *New Phyt.*, vol. 8, p. 43, 1909; Hill and Hanley, *Jour. of Ecology*, vol. 2, p. 36, 1914; F. W. Oliver, *N. Phyt.*, p. 98, 1912).

An important though indirect effect of rainfall on distribution is an outcome of the soluble character of the salts upon which plant-life depends. In regions of high temperature, evaporation and capillarity bring back to the surface the salts washed down by the rain, and if evaporation be in excess of precipitation physiological drought results. In temperate climates however, where the rainfall is high in relation to evaporation, the effect is to deplete gradually the surface soil of its nutrient salts, especially of the more soluble, and this leaching is usually accompanied by an increase of organic material and the attainment of an increasingly acid reaction. In the case of dunes and woodlands it has been possible to show that the changes thus brought about are accompanied by changes in the character of the vegetation, and comparison of dune systems on the east and west coasts indicates the importance of rainfall in this connection (cf. Salisbury, *Ann. Bot.*, vol. 36, pp. 391–431, 1922; and *Jour. Ecology*, vol. 9, pp. 220–240, 1922; vol. 13, pp. 322–328, 1925). Since the leached salts are carried down into the valleys or low-lying ground, we have here a cause of differentiation of the vegetation both in time and space. Thus in general lowland vegetation tends to approximate to the type we associate with basic soils, whilst upland vegetation, whether the underlying rock be calcareous or not, tends to be of the type we associate with acid soils, poor in mineral salts. The change in time which we term succession is well shown by sand-dunes, which begin with a covering of Marram Grass or Couch Grass, and in this country culminate in vegetation of a heathy character.

In oceanic climates soils derived from whatever rock will tend to become poor in mineral salts and more and more acid, whilst in arid continental areas the surface soils will tend to become alkaline. It is only in climates of an intermediate character that the soil conditions in this respect will remain relatively stable.

Dune systems offer peculiar advantages for the study of the details of succession, inasmuch as the sequence in space corresponds to the sequence in time; moreover, it has been possible in some systems to determine approximately the absolute as well as the relative time intervals. Dunes and shingle beaches are at their formation the edaphic representatives in cool climates of the deserts of warmer regions, but with the progress of time the soil develops an increasing water capacity, so that the same annual precipitation suffices to support less xerophytic vegetation. This increase of the moisture in the soil is mainly the outcome of the activities of the plants themselves. Similarly we find that with the

passage of time the marsh or bog tends to rise in level with the accumulation of plant-remains, and, as Dachnowski showed for the bogs of Ohio (*Geol. Survey of Ohio*, 4th Ser. Bull 16, 1912), the aquatic and marsh communities give place to woodland. Indeed, observations in this country, in India, in South Africa, and elsewhere seem to point to a general tendency on the part of vegetation to modify the extremes of habitat conditions towards the mean. Always assuming the absence of interference by man, the stages in succession from desert on the one hand and from aquatic and marsh habitats on the other, converge towards a mesophytic community, but once this latter is established there continues a more or less secular change associated with the continued action of climatic factors.

Thus the effect of climate can be modified by the plants themselves, but there is further some evidence that even the actual climatic conditions are not uninfluenced by the vegetation. That trees modify wind action is obvious, and once they become established in treeless areas, as in the grassveld of South Africa, an invasion takes place from their shelter. Further, the available data appear to show that precipitation is greater in an area of forest than in an equivalent area of grassland, the effect being greater the higher the altitude. The abrupt change in climatic conditions as we pass above the tree limit on mountains gives added weight to this view. Whether the destruction of forests within historic times in Northern Africa, Greece, Tartary, and elsewhere has produced a change in the climatic conditions is not certain, but it seems as probable that this has been a contributing factor in producing the present arid conditions as that they are entirely due to a secular change in climate. (For references cf. G. Huffel, 'Economie Forestière,' vol. 1, 1904; "Forest Influences," No. 7, *Bull. Forestry Div. U.S. Dept. Agric.*, 1893.) In the interior of woodlands the extremes of temperature and humidity are not so great as in grassland, hence species may flourish in one type of plant community in one climatic complex, and in another occur in a different community. In our own flora, for example, the Ivy-leaved Bell Flower (*Wahlenbergia hederacea*) is found in open grassland in the humid conditions of the west, whereas in Kent and Surrey it is restricted to bogs or damp woodland.

It is important to recognize that the extent to which the capacity of the plant can be exercised to adjust its habit, its structure, its internal organization, and its habitat to the change in environment is probably determined chiefly by the pressure of competition. For with each departure from the optimum conditions for a species the necessary adjustments must entail a diminution of vigour, perhaps in the rate of growth, perhaps in the output of seeds, which will render it less efficient for maintaining its place against other plants. Since the rival species will often differ in kind as we follow the limits of a species range, it is apparent that though a certain precipitation may be the limiting factor

for its occurrence in the west, an appreciably higher or lower rainfall may correspond to its limit in the east.

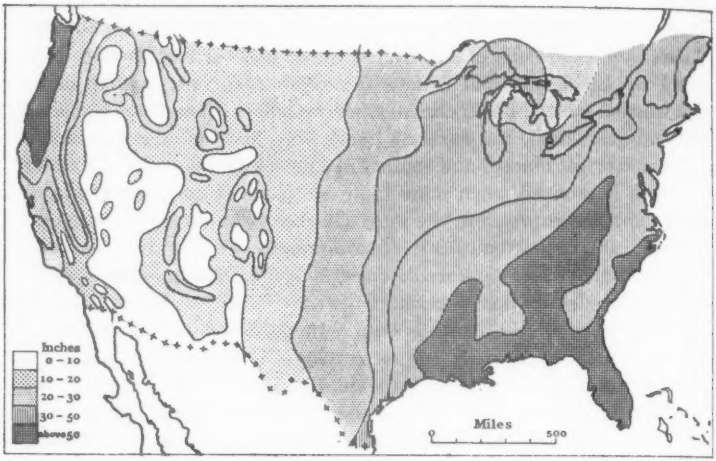
But despite the obvious discrepancies which our consideration of the modifying factors would lead us to expect, to no single climatic factor do geographical ranges of species or communities more closely approximate than to those of rainfall. The excellent analysis of the relation between the climatic conditions of the United States and their vegetation, published by Livingston and Shreve (*Carnegie Inst.*, 284, 1921), shows that whereas most of the isoclimatic lines for single factors have a general east-and-west trend, the moisture zones, like those of the vegetation, approximate to a north-and-south direction (Fig. 11). A still closer approach is attained when more than one factor is considered, and of these combined expressions the most satisfactory so far utilized appears to be the ratio of precipitation to evaporation.

One fact however appears to emerge clearly from all attempts to correlate the distribution of vegetation with climatic conditions, namely, the inadequacy of the existing data. In particular we need the co-operation of the geographer and meteorologist in the production of maps showing the distribution of mean wind velocity, the distribution of the humidity deficit, and maps showing the incidence of extreme conditions.

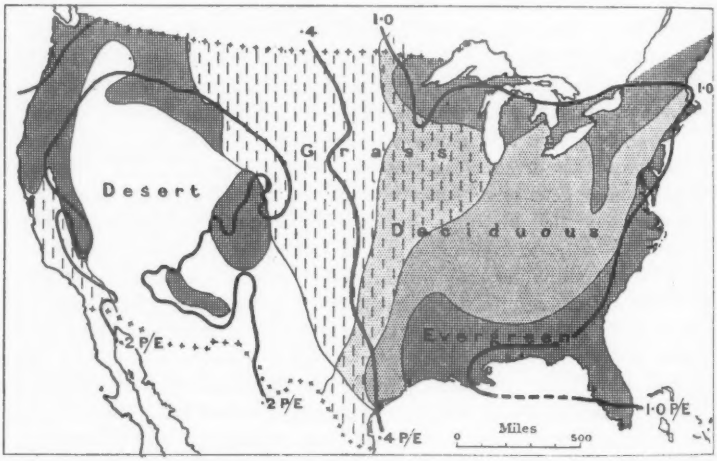
The present method of recording humidity at 8 a.m. and 8 p.m., if defensible on any grounds, gives no indication of either the average or the extreme conditions which chiefly affect vegetable life. Entirely new methods may require to be adopted, and in this connection attention may be called to the work of Garner and Allard (*Jour. Agr. Res.*, 1920), who have shown that the time of flowering and the mode of growth of a number of plants can be considerably modified by the relative lengths of day and night to which they are subjected. A short day accelerates the reproduction of some species and retards reproduction in others, whilst some appear to be entirely unaffected. It is apparent that such response may play an important part in determining the latitudinal limits of species, and even the aspect of a slope on which they grow and the type of community they inhabit. Not only is the amount of light an important climatic factor in itself, but it can to some extent replace the need for heat (cf. Wiesner, 'Unts. u. d. Lichtgenuss der Pflanzen,' p. 704, 1895).

So far we have intentionally made but slight reference to the geographical distribution of economic plants, and indeed have emphasized the important part which competition plays in determining the areas of wild species. It is apparent that this factor is in large part eliminated in the case of cultivated plants. The potential area which garden and crop plants occupy is much greater than if competition were allowed free play, but it is dependent on the same physiological principles as that of feral species. But the actual, as contrasted with the potential, limits are determined by economic factors that often have but little connection

with the biology of the organism. The successive zones of market gardens, pasture, and arable land around many large towns are clearly related to cost of transport, land values, etc., and not to any zonal differentiation of the conditions for growth. Economic plants are not



11a. Rainfall in U.S.A.



11b. Proportion of Precipitation to Evaporation from Free Water Surface (modifed from Livingston and Shreve)

necessarily cultivated where optimum conditions obtain, but where yield produces an adequate return on outlay. Nevertheless the same factors which prevent wild species reaching their potentional limits will frequently render cultivation unprofitable. Wheat, for example, can be

grown in the Orkneys at 59° N., but the yield does not justify its cultivation much beyond 52° N. (cf. Percival, 'The Wheat Plant,' p. 4: London, 1921). The fact that a continental climate favours wheats producing "strong" flour whilst an oceanic climate favours wheats which produce "weak" flour is a more potent factor in determining the geographical distribution of these strains than the relative prices which their respective types of flour command.

In any consideration of the relationships between organisms and climate the problem of acclimatization is one of extreme importance. At the outset, however, we must clear our minds of the ambiguity which surrounds this term. In its common use acclimitization is often applied to the process of successful cultivation of a foreign species in a country possessing a climate different from that of its provenance. Such introductions have often been successfully accomplished, and if the species become naturalized are of interest as indicating the potential as distinct from the actual range of the species concerned. But such instances have no bearing on acclimatization properly so called, which term should connote a training to withstand conditions of which the strain as introduced was, in its unmodified state, potentially incapable. If, however, it can be shown that species can be trained to withstand climatic extremes beyond their normal range, it is clear that data as to the distribution of species in the past, as compared with that which they occupy at present, can have little, if any, value as evidence of climatic change. Moreover, the use of plants as indicators of the sum-total of climatic conditions or the characterization of climates by vegetation as suggested by Koppen ('Versuche einer Klassifikation der Klimate') would be open to the gravest objection.

Actually, however, the evidence for such change in climatic tolerance is meagre in the extreme, and, difficult though it be to prove a negative, the data available seem at least to indicate the extreme rarity of its occurrence. One of the most cogent arguments that can be adduced for this view is, that of all the half-hardy trees and shrubs which have been introduced into this country, some of which have been in cultivation from before the time of Turner (1548), none, so far as I am aware, is any less hardy than at the time of its introduction. *Spartium Junceum*, introduced by Lord Cobham in 1548, and *Jasminum officinale*, which was probably introduced much earlier, are still liable to be injured by frost despite their sojourn of 375 years in this country. The Strawberry tree (*Arbutus unedo*), which as a native of the west of Ireland might be expected to be a suitable subject for acclimatization in this country, has been in cultivation for at least 175 years, yet it was badly injured in many localities during the winter of 1916–1917 even where it had been established for forty years (*Jour. R.H.S.*, vol. 43, p. 409, 1919). Similarly, *Buddlea globosa*, introduced 150 years ago, would appear to be as tender as at the time of its introduction, despite the cultivation of generations of

plants from English seeds and cuttings. *Leycesteria formosa* is still often killed by sharp frosts of even short duration, although more than 100 years have elapsed since it was first cultivated. Examples might be multiplied *ad nauseam*, not only from our garden trees and shrubs but also from amongst herbaceous perennials. No one will deny that the modern strain of *Coreopsis grandiflora* is a thing of beauty, but it is a joy of problematical persistence despite all attempts to select for hardiness. Moreover, the areas of cultivation of partially hardy plants, such as the climbing potato (*Solanum jasminoides*), the fig, and the pomegranate, do not appear to have become extended except within the same climatic zone, and it is a matter of some doubt as to whether the area of cultivation of the vine has not even considerably diminished. It will probably be argued that the cultivated races of hardy winter wheats or the geographical races of pines which differ in their resistance to climatic extremes are evidence of climatic adaptation. But these merely represent in the one case an artificial selection, in the other a natural selection, of already existing strains. The hardiest winter wheats would appear to be those which possess the highest sugar content, but this character appears to be more or less constant for a given strain, and whilst exposure to extreme conditions will eliminate the strains which possess a low sugar content, there is no evidence that the amount of sugar in the resistant strains will be permanently increased. That many, if not most, species are aggregates of races which differ in their climatic endurance is highly probable, and until they have become sorted out by the forces of nature, the species will probably not have attained its potentional range. Nevertheless, in the majority of present-day species this segregation would seem to be an accomplished fact, and the boundaries of their range relatively stable. The evidence from the fossil history of plants leads us to the same conclusion. In spite of all the uncertainty that surrounds the Pleistocene glaciation of Northern Europe, we can safely assert that the advance and retreat of the ice-sheet was a sufficiently gradual process to permit of ample time for the acclimatization of the warm temperate and sub-tropical types that occupied Britain and France in the early Pleiocene.

But the investigations of Mrs. Clement Reid seem to leave little room for doubt that this warm temperate flora as a whole was driven south considerably beyond the margin of glaciation, and indeed the migrations of plants which the fossil record generally indicates are inexplicable unless we assume a relatively high stability in their relations to climatic conditions. If it were not so, why has not Sequoia returned to occupy some of its former area in North America, or why has the Maidenhair tree remained confined to China and Japan? Why have the beech and hornbeam disappeared as native trees from Scotland since post-glacial times (cf. Erdtman, *Four. Linn. Soc. Bot.*, pp. 449–504, 1824) and *Tsuga canadensis* ceased to be a constituent of the Polish flora?

(Kozlowska, *Bot. Gaz.*, Ap., 1924). Such facts force us to recognize that the climatic boundaries of species, difficult though they may be to define in terms of their physical environment, are of a comparatively secular stability, and even though our attempts to analyse the causes attain but partial success, the plants themselves should prove invaluable as integrators of that complex of conditions which we term climate.

Finally, we may mention that, as pointed out by Grisebach in 1847, some species may be so young as not to have yet attained their climatic limits: a view that has been elaborated in recent years by Willis (cf. 'Age and Area,' Cambridge, 1922). Nevertheless for a large number of species, if not for the majority, the climatic limits as determined in the presence of competition would appear to have been reached. Indeed, the rapidity of the spread of some introductions into Britain during recent years, such as the Monkey Flower (*Mimulus Langsdorfii*), the Canadian Pondweed (*Elodea canadensis*), the Rayless Chamomile (*Matricaria suaveolens*), and Buxbaum's Speedwell (*Veronica Buxbaumii*), rather discounts the view that the attainment of the climatic boundaries by a species is a secular process.

Our review has shown how many factors may modify the reaction of plants to climate, but it is only by a realization of this complexity that we can hope to attain a better understanding of the relationship that undoubtedly exists, and it is only when observations are made with a full appreciation of the modifying influences that they can have any permanent value. Thus, far from deterring us from the accumulation of further data, the realization of the inevitable discrepancies should encourage us in a more minute examination of the facts.

Much remains to be done on the lines of primary survey, both in the lesser-known parts of the Earth and even in well-explored lands like our own. Unfortunately, such studies on extensive lines have sometimes suffered from the facile generalizations of those whose statements have been based on but a superficial acquaintance with the region described. The time has long since passed when a few months' sojourn in a strange land by the traveller unequipped with a definite problem and technical preparation could add materially to the sum of ecological knowledge. It is only by the active co-operation of the ecologist and trained geographer that we can hope to unravel the warp and woof of climatic control, and it is in the hope of assisting towards that *liaison* that I have ventured to adumbrate this problem.

Before the paper the PRESIDENT (Dr. D. G. HOGARTH) said: I have great pleasure in introducing to you Dr. Salisbury, who is Reader in Plant Œcology in the University of London. He is going to speak about those conditions of climate and the like which have an effect upon plant life. I have read his paper in proof and, though no specialist in this subject, was able to form the opinion that it is extremely valuable and likely to be interesting.

Dr. Salisbury then read the paper printed above, and a discussion followed.

Dr. A. W. HILL (Director, Royal Botanic Gardens, Kew): I am afraid I have not very much to say on what Dr. Salisbury has put before us. I had the privilege of reading his paper beforehand, but as he has not referred in his lecture to much that is in his written paper the ground has been rather cut from under one's feet. Towards the end of his remarks he referred to acclimatization. I suppose one of the important matters in connection with the acclimatization of plants is their response to moisture as well as their ability to withstand a low temperature. For instance, one of the cacti referred to in the paper is said to be capable of resisting a certain amount of low temperature. That plant of course grows in a dry spot, and I imagine that if the temperature were not quite so low but the air much moister it would be far more fatal to such a plant than dry cold. In speaking of acclimatization in connection with the Ice Age, the moisture of the atmosphere as well as actual degrees of temperature must be taken into consideration.

With regard to general questions of acclimatization, it does not appear possible to alter the constitution of any particular variety or form of a species and make it more hardy; our only hope of success in acclimatization efforts is to find some natural varietal form that chances to be more hardy than others owing to its growing at the northern limit of its area or for some other reason.

Then there was a point in regard to the celandine (*Ranunculus ficaria*) and its fruiting, which Dr. Salisbury states is mainly a matter of temperature. It seemed to me, in studying this particular plant, which I had occasion to look at some time ago, that it is rather a case of the success of vegetative reproduction over fruiting—a sort of laziness on the part of the celandine, if one may say so, in taking an easy way of reproduction by bulbils, because if you cut off the flower heads of the celandine that have been out for a day or two, and put them in water, they will usually set good seed. Normally, however, the production of bulbils appears to starve the plant and prevent the formation of seeds. Dr. Salisbury may say it is owing to insufficient temperature and that under warmer conditions seed setting would occur.

Another point with regard not so much to the acclimatization of plants but rather in the reverse direction may be mentioned. The common antirrhinums and wallflowers still to be seen in old-fashioned gardens are perfectly hardy and will stand a hard winter; but now, as the result of selection and cross breeding, varieties with æsthetic flower tints have been produced, and the constitution of these modern varieties has been so much weakened that they will not stand even a moderately severe winter. We are thus tending to produce less hardy races of garden plants.

Mr. H. N. RIDLEY: I have listened with very much interest to Dr. Salisbury's paper. I had the pleasure of reading the proof beforehand, and I made a few notes. First, I may say I agree with Dr. Hill, but I think in many of the cases where a plant develops rhizomes or large quantities of bulbils it actually takes off from the power of reproduction. I have noticed in the Tropics that plants tried, and preferred, to propagate steadily by rhizomes or bulbils if they could do it to save the bother of producing seeds.

The most important factor in the spread of special plants through the world really lies entirely in their plasticity or adaptability and their methods of dispersal. The plants which show the greatest adaptability that I know of in the world from the point of view of widespreadness and standing any kind of climate nearly all come from the temperate regions. Such plants as the common

reed, the common *Polygonum mite* and *Hydropiper* which we get on our heaths, the bracken, and even the common plantain, grow just as well on the Equator, if given a chance, as here in England.

In cultivating plants in Singapore we noticed that we could cultivate tolerably, with seed production, a certain number of the European flowering plants, and especially those that came from places like Texas, such as zinnias, though not a single plant of ours would stand a year in England even if there was a good soft winter. Our trees would not even stand a short drought in Calcutta, but a good number of the plants we got from England grew fairly well, fruited, and reproduced themselves.

There are a few cases in which we have every reason to believe that well-known English plants originated in tropical Africa. Such are *Solanun nigrum* and two sowthistles, common enough in England, and *Cynodon Dactylon*. They grow all over the world now. The latter grows as far north as Marazion Bay, in Cornwall and Studland Bay in Dorsetshire. It apparently will not stand strong frost and snow on the top of it. It will stand anything else. It has gone much farther north in Europe than the south of England; in fact, into Germany, where it has succeeded in thriving.

When a change of climate occurs slowly the plants have a chance of modifying and thus adapting themselves to the climate. I once came to a little place on the seashore in the Malay Peninsula where there was one of those sedges which consist of perfectly wiry leaves, a wiry rhizome, and short stems—a regular dry thing like the *Carex arenaria* of our coasts. A little way off the woodlands came sweeping down and were moving on, on account of some streams which had got turned that way and were bringing the soil down with them. In the woodlands still persisted the plant, but now it was tall and had green flaccid leaves, so utterly different in appearance that if I had not been able to trace the one into the other I should not have imagined it was the same thing, and it had already received a new specific name. At the same time that there is that adaptability there is a very considerable amount of power of sticking out, as I may say, unpleasant changes of climate, and that, I think, is the cause of what Dr. Salisbury alluded to: the presence of deciduous trees in the tropical forests. We had a number of them in Singapore. In the thick forest there were trees that shed all the leaves, waited for twenty-four to forty-eight hours, not longer, and then put fresh leaves on and generally flowered afterwards. Nearly all these trees existed in the dry region in the north, in Siam. Furthermore, we had a very curious thing, a Gesneraceous plant, Boea, very handsome, that grew entirely on limestone rocks in the centre of the Peninsula, as wet as wet could be. Its relations were all further north in Siam on limestone rocks. There at a certain time of year they had a long dry spell. The plants withered completely up there, the leaves shrivelled and got brittle. The plant in the middle of the Malay Peninsula did exactly the same thing at the same time when there was not the slightest reason as far as one could see, and the rain was falling all the time. It persisted in keeping its own primitive character. The real reason for those plants being isolated like that is, in the Malay Peninsula, and probably it is the same in Brazil, that before the big "Rain Forests" came on there was a xerophytic period—I think it was in Miocene days, but I am not yet quite certain—in which almost all the plants were xerophytic. A change took place in the climate and the "Rain Forest" swept over the whole of that desert. Nothing is left except these plants sticking about on a few sandstone ridges and on the seashore. The plants hold on like that a considerable time, and that accounts for their extraordinary presence.

Dr. Salisbury mentioned in the paper the occurrence of an evergreen form of the common oak in Jamaica. It occurred to me that I found an exactly similar thing in Java. High up I came to a tree, in a place where trees had all been destroyed, which I did not recognize in the least. I cut specimens of it, for it was flowering and covered with leaves in January. When I got it home it turned out to be a sweet chestnut, which had been planted there. It had apparently turned into an evergreen plant.

The distribution of rain throughout the year is very much more important than the actual rain which falls in the year, and that is, of course, something which one cannot help knowing. When we were pushing the cultivation of Para rubber as far as we could all over the world I constantly received letters saying, " We have a rainfall as big as yours ; therefore we can plant the trees." But I had to write back and ask, " When is your rainfall ? " and when I was told " It falls from four to six months " I knew it was hopeless. A couple of months' drought will settle a tropical plant of that kind.

I think plants can acclimatize themselves to a very large extent, judging by the spread of certain weeds all over the world, especially tropical weeds. I have seen weeds common in the tropics of South America and the East Indies push up into the deserts of Egypt. They just hold on. In time they can adapt themselves a little more. That is a kind of acclimatization that goes on. The whole subject is enormously large, and I think there are a great many factors which have caused this mix-up of floras. There is a great deal to be done, more especially in what we have never yet attempted, namely, a systematic study of the life-history and, as far as we can get it, the geological history of as many plants as we can get hold of. That has not been done properly for any one plant. If we knew the full life-history and the geological history of the daisy we should have done a very great deal to begin with. The paper was extremely interesting and very suggestive.

Mr. F. KINGDON WARD : I have been extremely interested in Dr. Salisbury's paper. There are one or two points on which I should like to ask him certain questions. One very interesting point on which he touched was the distribution of plants beyond their true environment—I think he called them plant slums. That is a thing one sees a good deal in the big river gorges of Asia, where one sees the mountain flora coming down the river gorges and the sub-tropical flora from the plains creeping up as high as possible, simply following up the corridor as far as they can get. The result is that you find the more sub-tropical plants growing in forests seeding and fruiting in the usual way, and higher up the gorges you find the same plants growing, apparently, perfectly well, but somehow disturbed internally and not producing flowers, or very few. And the same with the mountain flora coming down from the tops of the mountains and apparently flourishing in these river valleys, but still not producing any flowers or fruit.

The question of the distribution of species according to climate seems to me to be very much involved, because climate is really only one of a great many factors affecting the distribution of the plants. I think it would be rather dangerous in almost any case to say that distribution was entirely stopped by a climatic factor. If you took any area of the world and described its climate roughly, the seasonal distribution of the rainfall, and the lower and upper temperatures, I think any botanist could tell you what type of flora would be met with. Supposing you were told that it was a desert climate and that it had, we will say, eight months' drought and four months' rainfall, a botanist would know almost immediately that there would be a considerable number of

annual plants, probably no woody plants, a certain number of perennial plants with very deep tap-roots, and so on. But no botanist anywhere could tell you what species would be found there unless he knew what part of the world you were dealing with. You would find the same type, whether in the desert in Mesopotamia, or the plateau of Tibet, or in Arizona or Australia, but the species would be quite different in all those areas.

Dr. Salisbury spoke of cactus as limited by certain climatic factors, and I think he might have added the date-palm, which is a good example of a plant whose distribution is almost entirely settled by climatic conditions, whilst the tree itself spreads beyond the area in which it will produce ripe fruit.

So much for climate and distribution, but there is one other aspect on which I would like to touch, and that is the question of climate and evolution. From what the lecturer said, it is quite evident that there are certain plants which can only exist—I suppose all really must exist within certain climatic limits; but I go further than that and say that certain plants can only be produced under certain conditions. I think you find that in the case of a genus of a very large number of species, such as the rhododendron, of which there are in the Himalaya and the mountains of Western China something like 400 or 500 different species. The case I have in mind is that of a region with two ranges of mountains about 25 miles apart. The summer climate of both ranges was practically identical. In the winter the climate was rather different. On the northern range there was a very slight snowfall; very cold winds and very low temperatures. On the southern range there was a very heavy snowfall, the snow actually lying on the mountains for seven or eight months in the year, and the flora of the two regions was entirely different. I do not say on the latter range there were more, probably on both ranges they were practically the same, but the species were entirely different, and although vegetative conditions in the summer were the same, the winter conditions were different. But it seems to me that the species found on the wetter range can only have been evolved there; and, what is more, they occur in a perfectly continuous region of high mountains which has this winter climate, and they do not occur in one outside that. Whatever the process of evolution which has taken place, whatever migration of the plants has taken place, it seems to me that there is pretty good evidence that those plants were produced right there on account of the particular climatic conditions. I do not think I have anything more to say now; it is such an enormous subject that one really wants more precise data before one can come to any very definite decision.

Dr. J. BURTT DAVY: I have listened with great interest to Dr. Salisbury's paper. With regard to the question of grassland and its dependence on rainfall, from investigations carried out in South Africa and in the United States I cannot help thinking that here again we have a complex of factors resulting in the production of a particular type of vegetation. It is not rainfall alone, for under similar conditions of rainfall in areas which differ in temperature, we get grassland in the one case and open Savannah forest, if I may be allowed to use that term, in the other. It is probable, as Dr. Salisbury intimated at another point, that wind has been a factor of greater importance in that case, than rainfall. In those particular instances the grassland areas are severely wind-swept during the dry season of the year, and that has a marked effect on the vegetation. Experiments on open grassland areas have shown that by protecting young trees from the wind it is possible to overcome local climatic barriers to tree growth, and that once a wind-break has been formed it has been possible to grow trees which could not be produced otherwise.

With regard to the development of the annual type of vegetation, I was glad Dr. Salisbury brought out the point of the open, as compared with the closed, association, as I think that is a very important, perhaps the dominating, factor. One notices this particularly in South Africa, for in the south-western area of the Cape Province one sees the development of an annual type of vegetation. It was a puzzle to me, for some time, to understand why we failed to find a similar type farther north in the plateau region of Central Africa. At first sight this difference seemed to be correlated in some way with the winter and summer seasonal rainfall; later I came to the conclusion that it was the closed formation of the vegetation which prevented the production of a large number of annual species.

With reference to the individuality of the organism, I think we must recognize the important part this factor plays in the distribution of species, and therefore also in plant acclimatization. When we consider the peculiar distribution of certain plant species, such, for instance, as *Abies balsamea*, in North America, ranging as it does from far north in Canada to a point well south in West Virginia, we wonder why it is so difficult to grow it in this country, when other species, restricted in nature to a much more limited range of distribution, both climatic and edaphic, can be grown so easily under very different conditions. Perhaps a more striking case is that of different forms, or races, of the common Douglas spruce (*Pseudotsuga taxifolia*) of the Pacific coast. I was interested, in my visit to North America last summer, to find that in the Eastern United States it is only the Rocky Mountain form of that species which will stand the winter, and can be grown successfully. The coastal form commonly met with in British Columbia and southward into California, does not thrive in the Eastern States, whereas in the British Islands we find that the coastal form and not the Rocky Mountain form does best. Yet when we come to examine these forms critically even the greatest splitters of species in North America have been unable, they tell us, to find any point of taxonomic difference between them. Here we have cases of peculiar individuality of character determining the adaptability or otherwise, of particular races of trees.

Finally, I would like to urge the importance of these questions to those of us who are interested in plant introduction; I am particularly glad, therefore, that Dr. Salisbury has brought the subject before the Society. In his paper he has emphasized a point which was not brought out so definitely in his remarks, namely, the desirability of greater cooperation between the botanist and geographer. This is a point I should like to stress. I do feel that botanists need more exact geographical knowledge than most of us possess, and if as an old member of this Society I may say so, I think geographers should acquire some knowledge of plant ecology. In reading the pages of our *Journal* from month to month one cannot but be impressed with that fact; one feels how very desirable it would have been if those who have recorded their travels had also given us more information about the vegetation of the countries which they visited. There is much to be done in that direction, and it is only by the cooperation of the geographer, the botanist, the soil chemist, the meteorologist, and other scientists that we can really get at the life-history of the individual species, which, as Mr. Ridley has told us, is of such very great importance.

Major T. F. CHIPP (Assistant Director, Kew): Acclimatization between neighbouring climatic units does certainly seem to have many instances, but when the climatic units are more separated and the frost factor occurs in one and not in the other, it is doubtful if we have any definite instances. As Dr. Salisbury has remarked, I do not think there are any definite instances in this

country in which a plant originally introduced as tender has proved, in historical times, subsequently to become hardy. There are many misleading examples in that direction. Plants introduced as tender have subsequently been found to be hardy, but there was nothing to show that they were not hardy on introduction. And again, subsequent introductions very often would appear to come from different habitat forms of the same species. Again, in Central African mountains the glaciers were, apparently at no very distant time, considerably lower than they are now, and in their retreat the flora of the plains has followed them up, and there is nothing, so far as we know, to show that the original sub-Alpine flora has become acclimatized and settled to the altitudes to which it originally extended.

There is one interesting point which I hoped Dr. Salisbury would touch on, and that is the trees of the Northern Hemisphere Generally they are prolific when introduced into southern lands, but, on the other hand, the trees from the Southern Hemisphere are very difficult to grow in northern lands. I do not know whether there are any single or complex factors relating to that on which Dr. Salisbury may be able to help us.

The PRESIDENT: Would any one else like to say anything, or to ask any question, before I ask Dr. Salisbury to reply?

Dr. E. J. SALISBURY: First of all, with regard to what Dr. Hill said as to the celandine. He asked why I attribute its distribution to temperature. Well, the records appear to show that the further south one goes the more freely the lesser celandine fruits, and, as I mentioned earlier, in hot seasons it tends to produce many more fertile seeds than when the weather conditions in spring are cool. Of course the reason why I did not refer to moisture when I was dealing with acclimatization is simply because our data with regard to humidity in the past are totally inadequate to base any scientific conclusion upon. I quite agree, of course, with Dr. Hill that after the hybridization of plants you may easily get more hardy strains, but I think Dr. Hill would agree that that is hardly acclimatization. As I understand it, acclimatization means that you train the plant to withstand limits which it could not withstand before, and of course when you cross with another strain, even if it be only another geographical strain, you are obviously bringing about permutations and combinations which one cannot regard as acclimatization.

I was very interested in the remarks that Dr. Ridley made, and particularly in his reference to *Phragmites*. As I mentioned in the actual paper, *Phragmites communis* is found as a salt-marsh plant in this country, and Paulsen records it as occurring in the Transcaspian desert. I think that is further evidence of its extraordinary plasticity; and, of course, we have another instance of the extraordinary plasticity of some plants in the occurrence of maritime species at very high altitudes. Not so very long ago, in this room, I believe, Dr. Hill referred to the occurrence of *Glaux maritima* on Mount Everest at an altitude of 14,500 feet. The endurance of maritime plants at those very high altitudes is very possibly associated with the fact that their capacity to grow in salt marshes is on account of their potentiality of developing very high osmotic pressures, and that osmotic pressure which enables them to grow in a soil with a high concentration of salts also enables them to withstand extremes of cold and desiccation.

I was also very interested in the remarks of the other speakers, but they touched on wide problems that it is obviously far too late for me to deal with now.

The PRESIDENT: We have not only had a very interesting paper but a most

interesting series of speeches following it. I am sure you will all agree that they have shown, if nothing else, that there is considerable diversity of opinion and an enormous range of material from which to draw examples and to produce theories, and that that range is by no means thoroughly explored. We who are not botanists can only congratulate those who are having such a large area awaiting exploration.

With regard to what Dr. Burtt-Davy said, I quite agree it would be good to have more cooperation between different workers in the geographical field. When reading of expeditions of one hundred years ago or more one is always struck by the fact that every traveller was everything. A man went as an archæologist, and he proved to be a botanist and also a geologist. That, of course, was possible because specialization had not developed. Now there is so much specialization that I am afraid the same ends can only be arrived at by multiplication of persons; but an expedition may well double the part of doctor and botanist. It is not that geographers who are not botanists fail to appreciate the enormous value of botany. I know from the little exploration I have done that I would have been glad to have had much more knowledge of plant-forms than I had; but specialization is now so much developed that opportunities do not come in early life to pick up different sciences. I am sure you will join with me in offering a very cordial vote of thanks to Dr. Salisbury for having given us such an interesting discourse, which you will see extended in the paper which will ultimately appear in the *Journal*, and also to the other speakers for having enlarged the field.

NOTES ON THE SPANISH ACCOUNT OF THE SOLOMON ISLANDS, 1568

Walter G. Ivens, Litt.D.

[THE following notes are sent us by Dr. W. G. Ivens, who spent several years in Mala (Malaita) and Ulawa on the staff of the Melanesian Mission, and has recently made a further journey there as a Research Fellow of the University of Melbourne. The notes are in elucidation of passages in 'The Discovery of the Solomon Islands' (Hakluyt Society Publications, Second Series, volumes 7 and 8, 1901). —Ed. *G.J.*]

Introduction.

P. lxxviii. n. "*The natives of . . . Ulawa know nothing of the origin of the worked flints that are always being turned up in their plantations, even affirming at Shortland Island that they had tumbled from the sky.*"

This statement needs correction. Flint occurs in Ulawa at many places on the hills *in situ*, and the mouths of the streams on the west side have a bar of flint pebbles. The name for flint and chert is *ngädi*, and the worked flints spoken of are called *ngädi weuwa*, the flints of the ancestors. Such flints lie about wherever there has been cultivation in the past. They often lie on the open ground without being "turned up" by cultivation. Axes when introduced were first called *ngädi:* now

they are called *häu* stone, or the English word is used in its Ulawa form, *hakis*. The axes used at the time of the visit of the first white people in modern days were either of obsidian or of a volcanic diorite or of flint. The two former kept a fairly good edge, but the flint gapped easily and a considerable number had to be used. Flint was the only one of the three obtained locally, but meteoric stones are found, and these were also used. These were said "to have fallen from the sky."

The process by which the flints were split was recorded by me and the formula noted.

p. xxx. "*The Spaniards set down* Malaeta, '*There is Mala*,' *as Malaita*."

Vol. 1, *p.* 25, *n.* "*Probably the natives pointing it out to Gallego said* 'Mala-ita' (*Anglicé*, '*There is Mala*')."

The editor thus suggests two words, *eta* and *ita*, as the origin of the *ita* in the name of the island Malaita. It is possible that the word *eta* was suggested by Dr. Welchman, who supplied etymological and linguistic notes. In the language of Bugotu *eta* = East (*ita* is unknown), and a Bugotu native pointing at Mala would naturally say *Mala eta*, "That is Mala up East," such adverbs of place being commonly used throughout Melanesia with the names of places. Thus, at the south end of Mala, a Sa'a man pointing to Ulawa, which lies east of his place, would say *Ulawa ta'e*, "That is Ulawa up East," where *ta'e* is the same as the Bugotu *eta*. The Spaniards seem to have written "Malayta" as well as "Malaita," and the former spelling would correspond more closely to *Mala eta* than does "Malaita."

The Solomon Island Government has reverted to the original name of the island, and now calls it Mala. Throughout its whole length it bears but the one name, Mala or Mara or 'Mwala. This, as Dr. Codrington pointed out, distinguishes it from the other large islands of the Solomons which have no single name for the whole island ('The Melanesians,' p. 5).

Similarly, the Government has reverted to the Spanish form, Guadalcanal instead of the form Guadalcanar, by which the island used to be known. However, the name of Aola still remains unchanged despite the note on p. xxxix., where Aula is correctly stated to be the right spelling. The name Auki (the Government headquarters on Mala) perpetuates another mistake of the "Labour Vessel" days, the proper spelling being Auke. The correct spelling of the island called Ugi is Uki, there being no *g* in the original language spoken by the people there. The native name of Ontong Java, Lord Howe Island, north-east of Ysabel, is stated by the Government authorities of the Solomons to be Leuneuwa. Mr. Woodford spells it Lewenewa in his 'Naturalist among the Headhunters,' but further inquiry will show that the natives themselves call it Lungiua. There is no *w* in the native

name for Santa Ana, the island off the east end of San Cristoval. The name should be spelt Ōa, *i.e.* with a long *o*.

P. xl. "*Mauriba,*" *present equivalent* "*Maeraha.*"

Vol. 2, *p.* 345, *n. Maeraha is the present word for chief in Malaita.*"

This note was probably supplied by Dr. Codrington. The statement that *maeraha* is a Malaita word appears in his 'Melanesians' (p. 51). It is however a San Cristoval word, and does not occur on Mala or Ulawa. The correct spelling is *Mwaeraha*.

The Spaniards, like all other European visitors, expected to find chiefs everywhere. As Dr. Rivers writes ('Social Organization,' p. 165): "The European official who visits a new region will at once ask for the chief. Sometimes the real chief steps forward, in other cases the place of the chief is taken by some other man." In all probability the first inquiry of the Spaniards was for the "chief." In the case of Mala and Ulawa it not infrequently happens that any person pushing himself forward, and thus being regarded by the visitors as a chief, would be a *ramo*, a fighting man, the chief himself being seated in the rear of the gathering and making no attempt to show himself. In negotiations with visitors the *ramo* bravo did all the preliminary business.

The word for chief at Uhu, Mala, where the Spaniards called, is *araha*, with a plural *mo araha*. The form *moaraha* may perhaps be considered to be the origin of *mauriba*, but, personally, I think that what the Spaniards heard and recorded was the word *mauriha*, "living beings," men, and not apparitions, ghosts, *akaro*. The natives at both Uhu and Ulawa would have been deliberating whether their visitors were men or ghosts, and an examination at close quarters would cause them to exclaim that they were really *mauriha*. The word *mauriha* is thus used both on Mala and Ulawa. I have a folk-lore story in the language of Sa'a, South Mala, where a man declares himself to be a *mauriha*, a living being, and not an apparition or a devouring spirit. Dr. Codrington refers to the people of the Banks Islands, who on being asked by the earlier voyagers what they were, replied that they were men, *ta-nun*, and not ghosts, *ta-mate* (*ta* = *man*) (*Op. cit.*, p. 21).

The Ulawa word for chief is *alaha*, and the plural *mwa alaha*.

The attitude of the people of Ulawa towards the Spaniards may be judged from the following account of what happened in modern days when ships first began to come about.

Before ships began to visit Ulawa one was seen in the offing. Smoke arose from it and figures of men moved about on it and clothes were hanging out. These were taken to be the ghosts of those whom the men had eaten. Recourse was had to the local ghosts to remove the thing. Fear was expressed lest the ghosts from the ship come ashore and eat up Ulawa people. All went into their houses and shut the door, but the priest down at the beach still uttered his incantations. Some years afterwards an object was sighted at sea. It stayed there for days with

the sea birds circling round and settling on it. Divination was made and sacrifice offered, and the ghosts said it predicted a good catch of bonito. One man after divination said it was not a "devouring ghost." A company paddled out to it and disturbed the birds, whereupon the fleet came to a standstill and every man called on his ghosts. Then they begged the ghosts to make the thing drift ashore. Creepers were procured and the object was dragged ashore. It was a square iron tank, and full of round navy biscuits. They opened it by breaking in the side. The biscuits were smelt, and some of the more venturesome people made to taste them, but were deterred by the shouts of the rest. "Was it not the flesh of ghosts? Had it not fallen from the sky?" The biscuits were thrown away or hung as pendants from the neck or tied in festoons in front of the canoe houses. Some years after, when canoes came from Uki telling of the coming of ships, and bringing axes and tobacco, the Ulawa people said, "Why, that must have been what we saw and thought was a ghost"!

P. 46 *n.* "*Maramasiki Passage.*"

The second part of the name should be spelt *masike*. *Mara masike* means Little Mara—the island of Mala being divided by a channel into two parts, called Big and Little Mala. The peoples of Uhu and of the neighbouring portions of Big Mala have no *l* in their language, and speak of Mala as Mara. The dividing channel is called in the Admiralty chart Mara Masike (with the correct spelling); its native name is Su'u Rodo, the dark "passage," or Laloi (Raroi) Su'u, in the *Su'u* (*i.e.* "passage"). Dr. Codrington spells the word as *masiki*, being influenced possibly by the Oceanic word *riki* = little, *ma* being regarded as the usual adjectival prefix; but the word seems to be a separate one, *i.e.* with no prefix *ma*.

P. 46. "*Near to the end of the island we put into a small cove, and they shot arrows at us.*"

Vol. 2, *p.* 350. "*They anchored where the Indians were able to shoot at them from both sides with arrows, and even with stones and lances.*"

This "small cove" is evidently one of the three landing-places in the bay known as Olu Su'u, *i.e.* Three Passages, about 2 miles west of Cape Zélée, and the first bay reached after rounding the cape going west. Their names are Palaule, Hulihuli, Tawaina. A little promontory called Malau (island) juts out to the west of the middle landing. Either Hulihuli, the middle landing, or Tawaina, the western, fits the description. But there is a stream of water plainly visible, right alongside and to the left of the western landing. Lying at anchor at Hulihuli (the word means "black ant") they would be exposed to attack "on both sides," *i.e.* from Malau and from the shore to the east. The village now called Na'oni, which is alongside the river spoken of, is peopled by immigrants from Big Mala, and their occupation probably

goes back to before the time of the Spaniards. They are sea-going people and use arrows as well as spears. The flint-tipped lances (p. 351) are no longer in use, nor do stones figure now anywhere on Mala or Ulawa as offensive weapons. However, the peoples of two villages on Ulawa, Su'uholo and Mouta, certainly used stones in their inter-village fights. They speak of *ipelu eni heu*, fighting with stones, but this may have had its origin in the practice of picking up the boundary stones between the two villages (only a mile apart from one another) and using them as weapons. The wigs *uhu mae*, hair of the dead, are now things of the past. The blue dye is no more in use. The ordinary word for spear is *noma, lula*. The darts or lances may have been shortened spears. At the south end of Mala there is a spear known as "the grip for pounding taro." This was probably about 4 feet long, and thus shortened to allow its use in jabbing at a man from alongside.

I have noted two incantations from 'Ähi'a, where the Spaniards landed, which may be adduced as local evidence of the one-time use of fighting bows by the people there.

P. 47. The Editor's chart shows the village of Mwado'a and the anchorage (*su'u*) at Su'u Teluhia as the site of the Spanish visit to Ulawa. But vol. 2, p. 352, gives a description of the site of their visit which can only fit the village 'Ähi'a, 5 miles farther south. There the village still is to-day in two parts, one on each side of the stream, whereas at Su'u Teluhia there never was a village, and Mwado'a village is three-quarters of a mile further north and not in view from the sea, but 'Ähi'a is right on the cliffs at the anchorage. Catoira evidently refers to the people on one side of the stream singing in answer to those on the other side, and this could only have been at 'Ähi'a, where the village is right in full view of the anchorage. The land on both sides of Su'u Teluhia was covered with thick forest till quite recent days. At 'Ähi'a the banks of the stream at its mouth, on which the village is built, are high, and it may well be said that there is a "plateau" on top. The mouth of the stream is closed by a bar of chert pebbles, and the Spaniards evidently sat on this bar and ate their meal.

P. 47. "*The women carry about a sort of fan.*"

This is probably the *ha'u*, an umbrella made of strips of the pandanus called *ha'u*, and folded. No woman ever moves without carrying a *ha'u*. The unmarried girls wear no covering at all; married women wear a "fringe," called *ake*, before and behind (p. 353).

"*Intending to eat us.*" Cannibalism was always held in abhorrence on Ulawa.

"*War shields.*" These were in use till modern days. They are called *talo*, and are made of a piece of stout bark, *uhukolu*, stripped off whole.

P. 48. "*Uraba.*" It is stated on p. 44 that there was on board a man from Marau Sound. This man probably supplied the name of the

island (which he certainly would know as he is stated later to have had relations at Uki), and he would pronounce it as Urawa, there being no *l* in his language. There is no *b* in the language of Ulawa or in that of Marau Sound, and the *b* was probably written by the Spaniards for a supposed *v* (cf. *caba* = *kava* island). The *w* of "Ulawa" has always puzzled people, some writing it as *ku*, "Ulakua" (*i.e.* a *q*), others as *u*, "Ulaua," others as *v*, "Ulava."

P. 134. "*blackening their teeth.*" In South Mala the pigment used for this purpose is called *taha*, and is made from a stream rock, *hău lawa*, which is pounded and baked. It is kept in a bamboo receptacle called *mwalu i taha*.

Vol. 2, *p.* 204. "*Things belonging to their demons, which were painted with horns, and they offer them such food as they eat themselves, and they had placed offerings of food for them in dark places.*" [*See also note on p.* 355.]

The "things painted with horns" are the wooden carvings of the Sea Spirits, *akalo ni matawa*, which are worshipped at Ulawa (cf. Fox, 'Threshold of the Pacific,' cap. x.). The horns are fishes, flying fish and skipjack (large garfish), with which these spirits are supposed to shoot men. These carvings, *ponota*, are erected over the apex of the canoe house on the beach, and the men's club house in the village. They are, of course, not "idols," but merely works of art. They are fastened to the ridge pole as finials. There is a photo of such a canoe house in Uki, showing the *ponota*, the carving, in Brenchley's 'Cruise of the Curacoa.' I have a photo of such a *ponota* showing a Sea Spirit, taken from a *ponota* made in Ulawa. It is "painted," *i.e.* coloured, in black, white, and yellow. The Spirit is holding a bow (which itself may be a fish) in his left hand and reaching for an arrow, a fish, with his right hand. His name is *Sü aleha*, Blustering bravado.

"*Offerings of food.*" This might refer possibly to the yams which are placed as offerings to the ghosts, *akalo*, of worship whose relics are kept in a receptacle of sago leaves, *ahu sao*, tied round the central post of the club house, *toohi*, in the village. These offerings consist of the canarium almond, *ngäli*, and yams, *uhi*.

P. 350. They probably anchored at night in Su'u Laha, a few miles from Olu Su'u. Other harbours on that coast between Cape Hartig *Rararo* and Cape Zélée, *Nielaha'u*, going east are Su'u Peine and Su'u Mweimwei, towards the shore end of Cape Hartig, and Sioru, between Su'u Mweimwei and Su'u Laha.

P. 352. "*Stars of shells*"; p. 353, "*white roses in her ears, which appeared to be made of bone.*"

Both of these refer probably to the *eho* clam shell ornaments worn by both men and women in the ears. The solid wooden ear plugs, *wo'uwo'u*, whitened with lime (and worn by men only), would hardly be spoken of as "stars." The *eho* have perforations radiating from the centre, and

three rows of tiny holes bored close to the rims. They are decorated, *mumu*, with bats' teeth, *sawalo*, and beads of the shell money, *ha'a*, strung on eight strings and fastened through the top row of borings. A single string of shell money passes through the centre of each *eho* and hangs down under the chin. The lobe of the ear is pierced and much distended, and the decorations, *mumu*, hang in the front and the *eho* itself behind the ear. Both men and women wear the *eho* at functions, but not at ordinary times. It would seem, then, that some big function had just taken place, possibly on the day previous, and the people had not yet discarded their finery. This would be borne out by the fact that the " chief " came aboard in all his finery.

A question arises as to how the Spaniards recognized this person as the chief. Ulawa has several chiefs in each village, and none of them has the paramount position which a chief occupied in a place like Sa'a on South Mala. 'Ähi'a being divided into two villages, with chiefs in each, it would be far from the truth to say that the question of any person being chief there was decided by the amount of ornaments he wore. Yet it would appear from the account that this is how they came to their decision. No one among the natives was wearing clothes, and, it being taken for granted that the Spaniards were on the look-out for a chief, as I have stated above, when they saw a person who was conspicuous by the finery which he wore they concluded that the chief was before them.

Now the elder men discard ornaments and wear only two big shell armlets of clam, *hato ima*. Also a chief, unless he be a young man, does not necessarily make himself conspicuous by the wearing of ornaments. If he be a young man and unmarried, *saanau*, he follows the fashion and puts on ornaments after the manner of the young men. We are driven, then, to the conclusion that this person of whom they speak was a young man. He may conceivably have been a chief's son or he may have himself been a chief, though his ornaments were not the proof of it. Seeing that the village was still *en fête*, he may have been a chief's son, the leader of the *malaohu* boys, the reason for the " binding," the segregating of the boys in the *taoha*. To " bind " boys thus was the prerogative of the chiefs, and was undertaken when a chief had a son of a suitable age. He then " bound " boys with his son as the leader, and every man who had boys of a suitable age and could afford the expense in pigs and food, placed his lad in the company, which was called *ho'ota ni mwane*, the holy " bond."

All of these boys—their ages ran up to eighteen and twenty—wore the beautiful shell ornaments of the place. Round the forehead a string of small white cowries, *talai puli ;* a decorated comb in the hair, which was limed ; a pair of *eho*, " stars of shells," in the ears ; a circlet of *roa*, black lip pearl, on his neck ; grass armlets, *pwaroha'a*, red and yellow, on the upper arm ; shell armlets, *kome*, below these ; wristlets of shell beads strung in patterns of red, white, and black, *ngäungeu nima*

(eat the hand); a similar belt, ***ha'a ni upu***, round the waist; large white cowries, ***lue ni 'ae***, below each knee; and anklets of red, white, and black shell beads, ***uri mwado***, tread the dirt. The wristlets and anklets and belt had small porpoise teeth fixed on each side. They were said to be ***launi ehu***, fully adorned, and it was a proverbial saying, ***launi mala malaohu***, adorned like a ***malaohu*** boy.

The person, then, whom the Spaniards dubbed the chief may have been a chief's son, a young man, which is a possibility, he being an ex-***malaohu*** would wear the ornaments; or he may have been an ordinary ***malaohu*** boy from the company in whose honour the feast had just been given. There is still the possibility that he was actually a chief in his own right, his father being dead, but if so he was unmarried. We have to remember, however, the custom of the chiefs not to push themselves forward or to make themselves conspicuous, and the people would be loath to let one of their chiefs adventure himself in an encounter with those of whom they were not sure whether they were ***mauriha***, living men, or ***akalo***, ghosts.

P. 355. "***A very large and broad temple.***"

This would be the men's club house, ***toohi***, in the village, and not the canoe house, ***taoha***, on the beach. The Ulawa word is ***taoha, oha*** being a San Cristoval word. At 'Ähi'a the ***taoha*** were situated at landings in the shore rocks, some little way from the village on each side of the flint beach, and only accessible for canoes.

"***A breastwork of boards.***" This is a good description of the fence, ***sasa'ae***, which forms the front of both ***toohi*** and ***taoha*** (see photograph in Brenchley, ***op. cit.***).

"***Many secret places and apartments.***" Both ***toohi*** and ***taoha*** had apartments fenced off where men (and boys in the ***taoha***) slept. No women were allowed in either.

"***A rostrum or pulpit.***" It is evident that the Spaniards had just arrived too late—perhaps by a day—to share in the ceremony which is connected with the boys who are called ***malaohu***. The reference on p. 353 to the men wearing palm leaves would seem to refer to the ***maomao***, the leaf of a young coconut split into ribbons and tied round the waist when dancing. Evidently, from the reference on p. 352 to "singing," a dance was in progress. (The people dance in the evening with singing.) It would be a dance in connection with the "rostrum or pulpit." It was customary for the peoples of Ulawa (and of South Mala and San Cristoval) to segregate boys for a period of several years in a canoe house, ***taoha***, on the shore. The segregation was connected with the catching of the bonito fish. At a given time, when a sufficient number of pigs was available (a hundred is not an out-of-the-way number), and a crop of yams had been specially grown, and coconuts gathered, and swamp taro collected, a great feast was held to celebrate the return of these ***malaohu*** boys to their village. In front of the ***toohi***, the club house,

a "large rostrum or pulpit," *tahe ni malaohu*, stage for *malaohu*, is erected, and on it the boys are exposed to the view of the village. The *tahe* is ornamented with carvings of swordfish, of bonito, of sharks, and of sea birds. The date of the Spanish visit, May 31, would allow of the yam harvest having been dug. The boys in the *taoha* slept in what might well be termed "secret places and apartments." The Spaniards, after landing at the village, may have gone as far as the *taoha*, and so caused a confusion in their accounts as to the "apartments."

"*Sheds in which they sheltered the pigs.*" Ordinarily the pigs roam about free, but previous to a feast they were put into styes. The only flesh meat on Ulawa was pork, and pigs were only killed at feasts, *malaohu* feasts, death feasts, wedding feasts. That the Spaniards found pigs' flesh hanging up in a house points to a feast having taken place just immediately before.

The canoes, spoken of as arriving from another place, would have come from Mwarada, a mile further north. They might have come to join in the dance and the festivities at 'Ähi'a rather than in order to attack the ship. In any case they would be armed, as no one travelled otherwise. Their return would seem to denote their surprise and fear of the strangers, whom they might have taken for ghosts, *ahalo*.

The segregation of *malaohu* boys has ceased on South Mala and San Cristoval, but certain villages on Ulawa have observed it in recent days.

P. 356. "*A man of Ulawa.*" This photograph is evidently wrongly named. The photograph is that of a man of Guadalcanal, and appears as such in Mr. Woodford's 'Naturalist among the Head Hunters.' The Ulawa shields were of wood, and the people did not wear their hair in ringlets.

P. 366. *n.* "'*Cao, cao.*' *In Ulawa and the neighbouring islands the word for away is* '*Wao.*'" The word intended is in Ulawa *wau*, not *wao*, and is not used by itself as a command to depart. However, at Wango, San Cristoval, where the incident probably occurred, the similar adverb *wao* is thus used.

P. 392. "*Bounding, stamping, and scratching up the sand with their feet.*"

The fighting man, *ramo*, shows his contempt of the enemy by tossing up the earth, *tarasi one*, with a backward motion of the feet. The old man of Ulawa (p. 356) was a true *ramo*.

"*Brandished their lances.*" The quiver is caused by a movement of the wrist, and not of the elbow, which is kept rigid.

An interesting point is the connection shown between the peoples of the West Coast of Big Mala (Uhu) and Marau Sound in 1568. Gallego refers to the typical Mala club, *ware ni hau*, a specimen of which was found by him at Marau Sound. The peoples of the islands of the east end of Guadaleaval are immigrants from Mala and speak the same

language as the peoples of Uhu and its neighbourhood. The migration, then, would seem to have taken place previous to the visit of the Spaniards. The *ware ni hau* was found commonly among the peoples of Big Mala as far as the dividing channel.

The Marau man taken to Ulawa had relations at Uki. This would point to a long residence on the part of his people at Marau Sound. A picture showing several *ware in hau* appears in my 'Dictionary of Sa'a and Ulawa Languages,' published by the Carnegie Institution of Washington.

With regard to Gallego's statement that water was found on the Three Sisters, the Ulawa people have a salutation which would seem to show that the water there has always been brackish.

THE BIAFO GLACIER

Capt. B. K. Featherstone

THE Biafo glacier, one of the largest in the Himalayas, is about 30 miles long and runs from the Hispar pass (17,475 feet) south-easterly to the valley of the Braldu river. The Geological Survey of India made a preliminary survey of glaciers in the Kumaon, Lahaul, and Kashmir regions, as reported in the 1907 Records of the Geological Survey of India. Unfortunately, the area covered did not include either the Biafo or the Baltoro glaciers, so that we are dependent on previous travellers for their records. These reports cover a period of over sixty years, and it will be of interest to recall their notes before giving the result of my own observations.

The first European to leave any record would appear to be Godwin-Austen, in 1861, who reported that the glacier was wedged against the opposite bank or left flank of the Braldu valley. The Braldu river, formed by the emissary streams of the Baltoro and Punmah glaciers, was entirely covered, and flowed under the Biafo glacier through a tunnel. Sir Martin Conway in 1892 took observations on July 31 and September 5, which enable us to determine the average daily movement of the glacier between these dates. These observations clearly show that the glacier had retreated since 1861, and was in active process of doing so.* The Braldu river in 1892 flowed in open daylight, the foot of the Biafo glacier being about a quarter of a mile short of its old position in 1861. It is reasonable to infer that in 1892 the glacier must have been shallower than in 1922, when I saw it, as Sir Martin Conway estimates that during the month of August the extremity receded a further quarter of a mile, leaving uncovered a wide moraine of earth and vegetation. By 1899, according to the Workmans on the occasion of their first visit, the Biafo

* The rate of recession comes out about 36 feet a day: sufficiently remarkable to invite inquiry whether anything like it has been observed elsewhere.

glacier had so shrunk that it barely reached the outlet into the Braldu valley at all. During the next three years this shrinkage in volume must have been arrested and an increase set in ; for Guillarmod in 1902 reported that the glacier had again advanced as far as the right bank of the Braldu river, driving before it a low frontal moraine. He further states that the ice was 600 feet thick, and that the Braldu river was being squeezed into a narrow bed. Six years later, the Workmans on their second visit in 1908 found it practically in the same position as in 1899, and it must therefore have shrunk again. In 1909 the Abruzzi expedition recorded that the steep front of the glacier showed no trace of frontal moraine, and that the river was flowing through a narrow gap between the valley wall and the steep front of the glacier ; this obviously indicates an increase in volume between 1908 and 1909.

In 1922 I made as complete a reconnaissance as possible in the circumstances. Proceeding directly from the rock at Korophon to the river's edge, I found the glacier abutting thereon, but of no great height. I climbed on to it and made my way in a westerly direction across it, keeping parallel to the river. It was impracticable to pass between the glacier and the river except in a few odd places where the river did not wash the edge of the glacier. About halfway across I reached two large pools of foaming water, some 20 feet in diameter, adjoining the river ; there was a ring of shallow water except in the actual centre, where it was impossible to judge the depth. From the middle of these pools the water rose in foam some 2 or 3 feet, like a fountain, indicating clearly the junction, with the river, of two streams flowing from the body of the glacier. These two streams were the same water which I had previously crossed, flowing in places on the surface, when I was making my way eastward to Korophon, some distance north of the river. They had found their way under the surface of the glacier until they joined the river in the manner described ; these holes were distinct outlets, and a considerable volume of water was issuing from both of them.

When about three-quarters of the way across I sighted the main snout and decided to make a bee-line for it, the ice looking practicable. Up to this time I had been picking my way fairly near to the foot of the glacier, and had met with no difficulty, but my short cut proved a very different proposition. The surface was wholly broken up into hillocks, which were separated by deep depressions of varying shape and size according to the intensity of the causative pressure. Now and then there would be caves with walls of dark-green ice, whose size it was impossible to judge owing to darkness. The hillocks are generally covered with detritus consisting of immense boulders or rocks or sharply broken fragments of rock *débris ;* at times it is so thick as completely to conceal from sight the ice beneath. It has sometimes incorrectly been claimed that the formation of these hillocks is due to unevenness in the glacier-bed, but the Workmans, amongst others, have shown that they are

caused by pressure of an affluent stream of ice joining the main trunk. Once formed they are carried downward for many miles, not changing their order, and even after some 15 to 20 miles they are just as thickly covered as when they were newly formed. In this case particularly, owing to the widening of the Braldu valley, the irregularities in the glacier-bed, and the pressure due to the entrance of several tributary streams, the hillocks were broken up into a confused mass without order, with deep crevasses here and there.

After climbing with difficulty over the uneven and rough surface, I found myself on a ridge of ice about 100 feet high, just above the main snout. At first sight it looked as though ropes would be required, but my porter went ahead, and we managed to find a way down with the aid of our alpenstocks. The descent was rather dangerous owing to loose rocks, and we did the last 10 feet or more on our sides and elbows. It is curious to note how rocks have a way of remaining fast on steep icy slopes such as this without sliding to the bottom, as one would have thought that the ice, being melted by the sun, might release them. It has been suggested that these rocks have been pushed up from below, but examination of those on the Biafo glacier shows this to be hardly possible. If they had been forced up from below they should be rounded and polished by friction, but the moraine on all the glaciers I saw was of rough, uneven, and splintered rocks, obviously having undergone no friction whatsoever. They must therefore have been deposited on the surface of the glacier, and not have been forced up thereto.

The snout or end of the glacier was a large irregular cavity formed by the glacier on one side and a wall of rock on the other, which was part of the side of the valley. A considerable volume of foaming water dashed out, and the inhabitants said that there was an excessive quantity of water that year, which might tend to show that the glacier was advancing. From this point down to the river stretched a moraine-like surface, over which I picked my way until the western extremity of the glacier was reached ; I then retraced my steps, past the two pools, to Korophon.

To sum up, at the date of my visit in 1922 the Biafo glacier was advancing, its end being right up to the Biafo river, and according to the natives it had been so for two years. They also stated that the glacier was forcing the river to cut into the opposite bank, causing great landslides ; in the event of a landslide on a sufficiently large scale, temporarily to block the river, the adjacent villages in the Braldu valley would be too high to be affected by the resulting flood, but those in the Shigar valley might suffer. I am inclined to the opinion that it is quite possible to ascribe some of the apparent variations in the observations of this glacier to their having been taken from different points. In front of the main outlet of the glacier to the river was a stretch of about 300 or 400 yards of the moraine-like surface, and the remainder of the glacier abutted directly on the river.

The latest reference to the Biafo glacier is taken from the 'Additions and Corrections to Routes in the Eastern Himalayas, Kashmir, etc., vol. 1, no. 1, January, 1925,' published by the Survey of India, and is as follows: "Mr. R. O. Egeberg of Indiana reports that in 1923 the Biafo stream could be crossed below the snout of the glacier, owing to the retreat of the glacier, by two enormous boulders and along the new moraines." It is difficult to draw any definite conclusion as to the glacier from this report: as regards the crossing of the Biafo stream, this would depend to some extent on the hour of the day.

SOUTH-WESTERN ANDALUSIA AND THE TARTESSOS PROBLEM

Südwest Andalusien. Beiträge zur Entwicklungsgeschichte, Landschaftskunde, und antiken Topographie Südspaniens, insbesondere zur Tartessosfrage.— Otto Jessen. (Ergänzungsheft 186, *Petermanns Mitteilungen.*) Gotha: Justus Perthes. 1924. 11 × 7½, pp. 84. *Illustrations.* 7.60 *M.*

THE first appearance in the long series of Petermann supplements of a monograph on a purely Spanish subject is an event of some importance to the student of Western Mediterranean geography: it would have been of still greater importance had the motif of the monograph been more purely geographical.

Dr. Jessen tells us in his Introduction that he went to Spain first in the summer of 1922 in the company of Professor Schulten in order to make a geomorphologist's contribution to the determination of the site of Tartessos, and it appears from a remark on p. 54 that he returned to Spain in the same company during the summer of the following year. The Tartessos problem thus furnished the initial stimulus of this monograph, of a considerable section of which it forms the leit-motif; it directed Dr. Jessen's inquiries, too, into a channel which made it natural that, when he moved out of the immediately relevant area, he was still principally attracted by one type of geological phenomenon. As a corollary to his preoccupation with a coast-line in which there are considerable breaches of continuity, his monograph is divided into separate and somewhat water-tight sections.

So far as the Tartessos section is concerned we must distinguish carefully between Dr. Jessen's contributions to our knowledge of the morphological development of the area, which have a value of their own apart altogether from the problem of Tartessos, and that body of evidence, totally distinct in nature and in value, which is adduced by scholars from the texts.

In the former category we have an admirable account of the tract of coast lying between the Huelva Bar and the mouth of the Guadalquivir, which the student of dune formations will read with interest, and which must be taken as superseding entirely Mr. Bonsor's somewhat popular description published in the Hispanic Society's monograph 'Tartesse.' Professor Schulten's hypothetical (and *a priori* most improbable) north-western arm of the Guadalquivir, entering the sea at Torre del Oro, is shown to have had no existence, while the confirmation of Mr. Bonsor's north-western arm, marked to-day by a line of lagoons reaching inland from the curious summer settlement of Matalascañas,

gives a definitive western limit to the island which lay in Tartessian times along the mouth of the Guadalquivir estuary.

In the same category with these geological data are to be placed the results of the archæological work carried out by Mr. Bonsor and Professor Schulten near the Cerro del Trigo, where a fishing settlement of Roman date, with salting-pits and with building material probably derived from the ruins of an older neighbouring settlement, has now been proved. This gives an eastern limit for the island, and one which is specially satisfying to the eye of the reader, since it supplies that counter-clockwise deflection of the lower course of the river within the historical period which is a common feature along this coast. So long as Dr. Jessen confines himself to this category of evidence he is on sound ground; it is quite otherwise when he comes to his general summary on Tartessos. Here he appears, in the eyes of the plain man at least, to confuse, or at least not properly to assess, evidence of very different values.

A short digression may be permitted here to call attention to the new setting in which modern studies have placed Tartessos, and incidentally to make clearer what is the source of the evidence to which we are referring. Before these studies Tartessos had been seen in a setting derived from the Eastern Mediterranean texts, where some scattered evidence was available, broadly speaking legendary in character and derived ultimately from Phœnician accounts.

Modern studies, receiving their impulse partly from direct archæological work in districts of the Atlantic seaboard, partly from a closer examination of a specifically Western Mediterranean text, the *Ora Maritima*, have deflected elsewhere the credit for much of the navigation formerly ascribed loosely to the Phœnicians. Overseas communications are now shown on archæological evidence to have existed in the Western Atlantic before, or at least independently of, the Phœnician traders. The relations existing between these traders and the maritime tribes of the West are still most obscure, but it is not now safe to assume that the share of the Phœnicians in the Atlantic trade of their time extended beyond their control in South-West Spain of the vital point of a chain, in which the navigations of the Tartessians and probably of another maritime people further north were essential links. Such a restricted view of Phœnician operations enables their period to be connected more easily too with the subsequent period, for which the evidence of the *Ora Maritima* is available.

The *Ora Maritima*, although, it is true, the work of a Roman proconsul of the fourth century A.D., is based indisputably on a Massaliote Greek original of the sixth century B.C., and furnishes broad lines of evidence for the period immediately preceding that of full Carthaginian domination. Only broad lines of evidence, because the inferences of detail are too closely dependent on the technique of textual criticism; the original is certainly overlaid by subsequent interpolations, and both have to be disentangled from their setting (fortunately for us, a very loose one) in the proconsul's work; allowance has to be made, too, for the reticences of the Massaliote Greek where his Phœnician and Carthaginian enemies were concerned.

To this Massaliote Greek, writing, in Professor Schulten's view, between 537 B.C. and 509 B.C., Tartessos is a country extending from the Guadiana (ll. 223–4; this and the following references being to the text of the Schulten edition—Barcelona and Berlin, 1922), or more strictly perhaps from the Rio Tinto (l. 254) to the Júcar (ll. 462–3). The inhabitants of this country are a people described as Iberians by Professor Schulten (Introduction, p. 30)

on the ground that they are neither Celts nor Ligurians, but they are outstanding among their neighbours by their wealth ("*divites Tartessii*," l. 423) and by their reputation as sailors—"*Tartessiisque in terminos Oestrumnidum Negotiandi mos erat*" (ll. 113–4).

It was this people, trading with the Œstrymnides from their Guadalquivir port, and the sailors of the Œstrymnides themselves, navigating their skin coracles (ll. 98–108), who maintained the Atlantic section of the sixth-century metal trade-route. Meanwhile Phocæan Greek and Carthaginian disputed the connection with the Mediterranean at Tartessos. Thus Tartessos the port had a significance derived from its location where Mediterranean and Atlantic meet, apart from the importance of the country Tartessos.

It is the problem of the exact site of this port to which Dr. Jessen addressed himself, and he appears to us, in collating the textual evidence with the physical, not to realize the inferiority of the former evidence on points of detail, where too much depends on the personal equation in delicate textual manipulation. The plain man, far from accepting Dr. Jessen's conclusions, will be more likely, when he looks at the diagrams on pp. 24 and 25, to conclude that no site within the limits of these diagrams was, or could have been, the site of the city described in the *Ora Maritima*. That text gives, in lines 283–290 (lines ascribed in the Schulten edition to the oldest stratum of text), the following clear elements of definition of the site :

(1) The city stood on an island on *all* sides of which (*undique*) flowed the river.

(2) The river ran in multiple channels both to the east of the city (l. 288) and to the south (ll. 289–90).

(3) The land intersected by the channels on the eastern side was such as could fairly, after due allowance made for poetic licence, be described as "*agros*" (l. 289).

The plain man will probably conclude that, if Dr. Jessen (who is here obviously uneasy about the Lammerer suggestion for the explanation of the multiple channels on the south) has persuaded himself, or allowed himself to be persuaded, that the neighbourhood of the Cerro del Trigo furnishes such a site, he is not good or safe company for a geologist or geographer.

When Dr. Jessen turns from the Guadalquivir section of his area to the adjacent sections, he takes with him, as we have hinted, a preoccupation with phenomena depending on the Late Pliocene–Early Pleistocene episode of regression and on the subsequent episodes of transgression and alluviation ; he is, in other words, concerned principally with the closing episodes of that larger sequence which led to the formation of Southern Spain and to the present delimitation of Europe and Africa. The larger view of his area was present in his mind, for he has promised us a further monograph, which will be awaited with interest, dealing with Southern Spain from this standpoint. It is a standpoint from which Bætica, as had already been seen by Calderón, has an interest and importance in Geodynamics, quite apart from its particular regional interest, although to Calderón, writing in 1893, geodynamic processes presented themselves in a somewhat simpler light than is now possible. But Dr. Jessen is not very consistent in this respect. He would have done better either to take the larger view or to exclude the pre-Pliocene episodes altogether. He does neither, for he takes us inland as far as the Algibe, and he quotes Calderón freely. He even reproduces Calderón's mistakes, for he ascribes with him a late Miocene date to the closing of the Bætic straits connecting the Atlantic with the Mediterranean (p. 9), whereas the Burdigalian Sea is

now accepted as the last sea to have passed freely between Penibætica and the northern mainland. The discrepancy is important, because between the Burdigalian and the Upper Miocene occurred the transgression south of the Rif described by Gentil, whose work was communicated to the Society by Mr. Ogilvie in 1912 and 1913. Dr. Jessen speaks too of the north-eastern dip of the Miocene at Carmona, which was surely an obvious confusion of Calderón's, repeating a similar error in the orientation of the Guillena–Coronel section. And his interpretation of Calderón's account of the Guadalquivir bend is as obscure as the original.

Quoting Calderón and other Spanish authors so freely, it is curious to find Dr. Jessen, with characteristic modesty, describing himself as carrying forward, in this part of his investigations, the work of Fischer, and complaining that the "Mangel an Vorarbeiten" prevented him from making such progress as he would have wished. For Fischer's general inspiration is not very evident in the monograph, and his particular work is only mentioned twice—in a reference to his not very happy theory of the origin of the great bend of the Guadalquivir near Alcalá del Rio, and in a later reference to his theory of the formation of the Moroccan Black Earths. Moreover, Dr. Jessen passes over in silence Dr. J. Dantín Cereceda's criticism of Fischer's æolian origin for these formations, although he quotes from H.-Pacheco's paper now embodied in the joint monograph in which that criticism was made.

With regard to the "Mangel an Vorarbeiten," it is of course the case that neither Cadiz nor Seville has been the subject of a provincial memoir by the Spanish Geological Survey, while Gonzalo y Tarim's work on the Province of Huelva was mainly concerned with the mining belts of the centre and north of that province. But more important than the lack of these is surely the lack of topographical maps on an adequate scale for the appreciation of such previous work as did exist. We may remark here that Dr. Jessen himself has not been very kind to those who may use his own work as a "Vorarbeit" in not giving a map or map-diagram to illustrate his Véjer section.

Considering his monograph as a whole, we may say that the limited geological motif suited the Tartessos and allied problems, but it does not serve to define a region in the proper sense, corresponding to the title of his monograph. There is no region of South-West Andalusia. There is Bætica, and there is Penibætica. There is also, it is true, the La Janda corridor, by which, strategically, Penibætica is turned, but it belongs really to Penibætica, and in any case Dr. Jessen is silent on its historical significance. Rather than a monograph, this is, as the author himself sees, a series of extracts from a note-book preliminary to a monograph. The note-book is however an exceedingly interesting one, most interesting often in its most incidental remarks. Some pages of vivid impressions, recorded by the author although he was making tiring journeys at an unsuitable season, send us back with fresh interest to the pages of Chapman and Buck; with a few exceptions, too, the common error has been avoided of neglect of the seasonal equation.

If the author has fallen short of a monograph proper, it has been partly from lack of time, but more largely from a bad grouping of his regional elements and from the over-emphasis of problems the solution of which, even if attained, can hardly affect our appreciation of Western Bætica as a whole, either in its geographical or in its historical setting, and which are not therefore the prime geographical problems of the region in question.

ROBERT AITKEN.

NEW LIGHT ON PETRA

Petra: its History and Monuments.— Sir Alexander B. W. Kennedy, LL.D., F.R.S., F.R.G.S. London: "Country Life." 1925. $12\frac{1}{2} \times 9\frac{1}{2}$, pp. xiv. + 81. *With Photographic Plates and Maps.* £4 4*s*.

THIS magnificently illustrated volume throws much new light on one of the most impressive and perplexing groups of monuments in the ancient world. It shows what it is now possible to do, with a well-organized expedition and expert aid of aircraft and scientific photography, on an almost uninhabitable site; and is a memorial also of persistent work and skilled cooperation on an unusually effective scale.

Petra is literally the "rock-city" which its name implies. It owes its existence and its position, as is well explained at the outset, to the peculiar structure of the district, and in particular to the necessary convergence of routes from north and from south at a natural pass through the double barrier interposed by ancient rock ridges between the coast regions of South Palestine and Sinai, and the great interior of peninsular Arabia. And the peculiar conformation of these ridges permitted the collection, even down to modern times, of a rainfall which on occasions may be considerable; the conservation of resulting flood water in a natural reservoir in the headwaters of the Wadi Musa; and consequently the maintenance of a bazaar and caravanserai city, commanding the pass, and therefore enabled to take toll of what has been at all historic periods a considerable volume of trade in both directions. The district thus made habitable is of considerable extent, between 2 and 3 miles in each direction, amply protected by rugged ridges and peaks, and itself consisting of the confluent gorges and gravel-choked valleys of the Wadi Musa and three principal tributaries, above the point where the main stream plunges westward into the gorge of Al-Siyagh, between the Dair plateau and the castle-like Umm-al-Biyara, which both attain heights of 3500 feet, and the latter considerably more. As the upper gorges are steep-sided canyons, first formed as is suggested now (p. 2) rather by "cracking" of the sandstone than by water erosion, it was not difficult to impound the rainfall higher up the side valleys and conduct it into the inhabited and cultivated areas by a tunnel and aqueducts, which will deserve one day an engineer's monograph to themselves. Probably, outside Rome itself, there is no single site which has more copious illustration of ancient skill and technique in this department, though it will be easily understood that, once left to themselves, no monuments are more exposed than waterworks to the ravages of the torrents on whose domain they have encroached.

But Petra was not a "rock-city" only. What was only vaguely appreciated before is now evident from the magnificent air-photographs here published of the whole site, and from the views of the numerous and extensive quarries: namely, that the central area is the site of a really stately city with buildings of ordinary masonry. The sandstone of the surrounding plateaux is of fine quality, and there are still sufficient ruins of built work to show that full advantage was taken of this excellent material It is always a puzzle what has become of the masonry of an ancient site. Sometimes there are later settlements in the neighbourhood, which account for wholesale spoliation; but here there are none. Alji, the nearest considerable village, is in the heart of the highland, and has never, apparently, been an important place; and Ma'an is 20 miles away, across the watershed to the east. But the half-buried doorways of some of the monuments, and frequent patches of rubbly talus

below the rock faces, are sufficient hint of what might be recovered by excavation. Revealed from above, Petra has the look of a fairly "fat" site, at least so far as its greater monuments are concerned; and the quarries already mentioned are eloquent of the quantity of building material that has gone into it.

All that we are likely to know of Petra, however, for a good while to come, is its rock-cut half; and of this the greater part is not in the "civic centre" between the large Roman building known as the Qasr-al-Bint, and the great rock-cut theatre, but in the suburban cemeteries, and on the surrounding hills with their fortresses and other "high places." The forts, being in considerable part built of masonry, have of course suffered severely: here again, however, adjacent quarries testify to the magnitude of their upper defences, for at Petra nobody carried building-stone very far.

Some of these ancient quarries are queer-looking places; the old stone-cutters were as pernicketty as Portland quarrymen a century ago, and shied at bad rock with an instinct that defies lay cognizance. Strabo wrote long ago that the Nabatæans were "very religious," and one of the ways in which this peculiarity has been illustrated by their Arab successors and by European explorers is by ascribing to it all sorts of queer rock-cuttings, or abstentions from rock-cutting, which may have as little to do with any kind of cult as the Tilly-whin caves at Swanage, or the "Latomie" of Syracuse. The present writer once had the luck to excavate such a quarry site in Cyprus, which had been converted first into the basements of Græco-Roman houses, then into rubbish dumps of Byzantine Age: in one place what at Petra would be a "sarij" had been merely spared because it had a Greek or Roman tomb inside (rather like Fig. 156 of this book) which had become the "holy place" of a Christian saint with the unusual name of "Not-made-with-hands" (*Akheiropoietos*), which did not describe the monument very well. Other odd stacks of live rock were of the same order as the earth-pillars which a gravel contractor leaves as guides in "cubing-up" his spoil. Similarly at Petra, "monuments" even so conspicuous as the "obelisks" of Fig. 164, and a good deal of the worked rock near them (compare the tottering mass on the right edge of Fig. 68); the "block-niches" of Fig. 197; much of the "high place" of Umm-Saikun in Fig. 47; most of Figs. 42, 43, 44, entitled "cultural remains"; and almost all of the "high places" of al-Najr in Figs. 39 and 41, have characteristic quarry-worked profiles and surfaces; and probably a quarryman would detect more examples on the spot than are recognizable even in the beautiful photographs of Sir Alexander Kennedy. Doubtless, as in the Cypriote example above quoted, tomb-cutting and quarrying alternated and were combined: of both processes there are numerous examples in these photographs. Some of the stairways and platforms, too, resemble the remains of partially rock-cut houses in the older parts of Cnidus, and on the back of the Pnyx and Museum Hill at Athens. They are not necessarily sacred because they include niches and "block-idols." In any comments on identifications which every one will admit to be provisional, regard must necessarily be had to the predilections of Dr. Dalman, one of the most pertinacious of Sir Alexander Kennedy's predecessors, who represented the German Evangelical Institute for the Archæology of the Holy Land, and had a commensurate enthusiasm for "high places," and as is stated here (p. 27) "has himself been the discoverer of a large number of Holy Places," and the like, to which indeed he mainly confined his attention.

There remain the free-standing rock monuments of "sarij" or "cistern" type, and the rock-cut façades, with or without chambers behind them, for

which Petra is chiefly famous among artists and connoisseurs. The majority seem to be funerary, and belong to types which are widely represented round the Eastern Mediterranean. The numerous niches raise the question whether cremation was practised at all commonly, side by side with the full-length burial which seems to have been habitual here. But niches are very convenient in basements and store-rooms as well as in tombs; and chambers whose position "is such that they are often in close proximity to—if they do not actually form part of—a series of places of cult" have a rather domestic air. The author is probably well advised in his insistence that a façade of some more or less architectural style is part of the normal outlay of a genuine tomb. Among the various styles, that which Sir Alexander calls "rectilinear decoration" (as in Figs. 73, 74) looks very much like the mason's rebating of the matrix behind a built-up veneer of better stone; and so may be of any period after Greek influence began. Tombs with moulded fillets in place are seen in Fig. 91 associated with tombs with the "rectilinear" groove. The "unusual ornament" above such a façade in Fig. 82 seems to be a much-weathered "crow-step frieze" like that in Fig. 88. The "plain cornice" façade is not necessarily earlier than the period of Greek influence, though it goes back to a cornice of Egyptian profile: for it occurs on the great vaulted chamber-tomb in Cyprus known as St. Catharine's Chapel, and on similar monuments on the Syrian coastland, which are not earlier than the Roman Age. The "plain cornice" indeed may be little more than the mark of a personal taste which preferred Egyptizing to Hellenistic designs. The "triclinium" type of interior should not be accepted as sacred without positive evidence, seeing that it is a common type of tomb, in Syria and Cyprus, in classical times. Inscriptions "which consist only of the name of the engraver, with a word equivalent to 'Hail' prefixed" (p. 77), are provokingly like those Græco-Roman ones in which the "word equivalent to 'Hail'" is used also for "Farewell," and the name is in the vocative, representing the person buried below. As there is "a very large number of them," it looks as if they represented, as in Greek lands, the poorer sort of graves, which could not afford a chamber, but would be earth-burials in the scree below the inscribed rock face; but as the text of these formulæ is not given, the suggestion must remain tentative. An inscription without grave, but certainly funerary, is quoted on p. 76.

The author raises an interesting question on p. 82, as to the tools with which these great monuments were cut out. A good deal of study has been devoted to this matter in Palestine, and there are numerous references to it in early volumes of the *Quarterly Statement* of the Palestine Exploration Fund; the modern mason's tools in some instances confirming the evidence of the tool-marks on ancient surfaces, such as must be ubiquitous at Petra, and indeed appear on some of the quarry-views in this book.

It is indeed much to be desired that some archæologist with expert acquaintance both with funerary customs of the Nearer East, and of the technique of architectural construction, including quarry-work, should visit Petra and supplement the valuable but occasionally rather speculative conclusions of Dr. Wiegand's party in 1916, which were only brought to Sir Alexander's notice after his book was in type. It is only fair to him to note that he did his best to bring out an archæologist from Athens; but luck was against him, and if the chance ever comes, a man with Syrian or Anatolian experience would be the most valuable.

While the main interest of Sir Alexander Kennedy's 'Petra' is inevitably "its history and monuments," over which he has spent so much pains, his

work will be memorable also for its revelation of the physical structure and climatic *régime* of a typical mountain desert. That it is by no means bone-dry, even now, is clear from the vegetation which appears in most of his photographs, and from the account of the great spate of 1847, which was witnessed by Miss Martineau, and described in her 'Eastern Life, Past and Present.' But the effect of long-continued exposure to these austere conditions is very striking; and the air photographs, no less than the more detailed views, are exceptionally fine illustrations of it. J. L. M.

REVIEWS

EUROPE

Roman Folkestone: A Record of Excavations of Roman Villas at East Ivear Bay, etc.— S. E. Winbolt. London: Methuen & Co. 1925. 7½ × 5, pp. xiv. + 200. *Plans and Illustrations.* 8*s.* 6*d. net.*

In this book the author describes in detail by way of a diary the excavation of the Roman villa he lately discovered on the cliffs near Folkestone. Such was his industry that in only two months' work the plan of the villas was uncovered, revealing two blocks of buildings comprising more than fifty rooms. The plan of an earlier villa was also revealed, though a good deal of it is conjectural. Considering the extent of the work the "finds" were few and by no means sensational. But the coins and potters' marks make it possible to fix the time of its habitation with a fair degree of certainty, viz. between the close of the first century A.D. and 370 A.D., with a possible gap of forty-five years, from 275–320 A.D. The most interesting find was a portion of a mosaic floor in room 40, the ornamental part being 10 feet square. It is, unfortunately, much broken up, the central part having been destroyed. The design is geometrical with guilloche, but no animal form as ornament. It is suggested that this villa was the residence and headquarters of an officer of the British fleet, of which an interesting and informing account is given. After a critical discussion of the Roman roads of East Kent, the author gives a lively and graphic sketch of the sort of life led in such villas. The work is well illustrated with twenty-one photographic plates, and a number of illustrations and plans in the text. An agreeable aspect of this investigation is the encouragement and help given by the Corporation of Folkestone, which has shown public spirit and enlightenment, and has supplied the means for preserving the more valuable parts of the discovery, as *e.g.* the mosaic pavement. It is to be hoped that other public bodies, when opportunity offers, will show a like sympathy with archæological research. E. A. P.

The Rocks of West Lothian: An Account of the Geological and Mining History of the West Lothian District.— Henry M. Cadell. Edinburgh and London: Oliver & Boyd. 1925. 9 × 5½, pp. xvi. + 390. *Thirty-three Plates, Portraits, and Illustrations.* 18*s. net.*

West Lothian, or Linlithgowshire, has a geology of exceptional interest and variety, and links the remarkably different geological areas of South-Western and South-Eastern Scotland. Its most striking feature is the occurrence of the oil shales, which have served as the parent of the world's mineral oil industry, and are still the second in importance of Scottish mineral resources. The geological story of this area has been summarized by Mr. H. M. Cadell

in an instructive and interesting volume, of which the title 'The Rocks of West Lothian' is less descriptive than the sub-title "An Account of the Geological and Mining History of the West Lothian District," as the former suggests an account of the petrology of the area. The book deals mainly with the general geology, and especially with the physical geography.

Mr. Cadell brings to his task a lifetime's study of the district. Several of the chapters are based on his contributions to technical serials, but they have the advantage of being brought up to date; they include information which is not readily accessible, such as the details of the bore in Midhope Glen, that confirmed Mr. Cadell's view as to the structure there, and disproved the supposed discovery of an additional seam of oil shale which has been called the Midhope Shale. Mr. Cadell interprets the geology of the district clearly and reliably, and helps to explain the problems by observations made during his wide travels. His artistic skill has enabled him to illustrate his explanations by diagrammatic views of the country under former geographical conditions. The earlier chapters deal with the oil shale and the oil-shale industry, the coalfields, the intrusive rocks, and the ancient volcanoes. He explains clearly the evidence for some volcanoes which were discovered by mining. In the development of the present topography he ascribes due influence to denudation during the prolonged period which intervened between the Chalk and the Glacial periods, and of which there are no deposits in the south-east of Scotland. The only available evidence is physiographic. He also gives an excellent account of the ancient river system, of which the channels are now buried under the Forth and its tributary valleys.

The chapters on the glaciation state the traditional view and bring out the contrast between the Edinburgh school, which founded the theory that boulder clay is the ground moraine of an ancient ice-sheet, and the Glasgow retention of the view that it is a marine deposit. The author states that the boulder clay contains no fossils except those derived from older beds, whereas in the south-west of Scotland it contains widespread marine indigenous fossils. Their apparent absence in the Lothians may be due to the boulder clay there having been less carefully searched for them. Mr. Cadell supports the ground moraine view by reference to its observations in Spitsbergen and British Columbia; but in both cases his evidence may be interpreted as supporting the submarine origin of the boulder clay, as it does not occur in Spitsbergen in association with the high-level glaciers, but only on low levels, and mainly in and beside the fiords. He gives a beautiful illustration of boulder clay under a glacier in British Columbia; but the glacier appears to be destroying and not making the boulder clay, which may have been formed below water and left on the land by uplift. The evidence of Antarctic geology with the absence of boulder clay on land and its formation on the floor of the Ross Sea, is not in accordance with the ground moraine theory.

The last chapters deal with the history of local mining, including an interesting account of the Hilderston silver-mine, which was worked early in the seventeenth century: the results of attempts to reopen it last century are recorded. In the account of the coal-mining of the district the author, as a descendant of the founder of the Carron Co., gives much valuable information drawn from the family archives. The book is well printed and richly illustrated.

J. W. G.

Enzyklopädie der Erdkunde: Landeskunde der Britischen Inseln.— Dr. J. Moscheles. Leipzig: Franz Deuticke. 1925. 6½ × 10½, pp. 95. *Ten Maps and Illustrations.*

This book, despite its limitation to less than 100 pages, treats of the whole general geography of the British Isles, and as an example of careful selection of material and of clear and concise treatment it is greatly to be commended. The first forty pages are concerned with the geography of the area as a whole, and it is in these that the author's wise choice of detail to be included is, perhaps, most apparent, and she succeeds in giving a logical outline of the salient facts. In the fuller account of the separate units which follows, emphasis is everywhere laid on the physical aspects, especially those of structure and relief, and the illustrations are chosen almost exclusively from this point of view. This emphasis is borne out by the fact that of the thirty-seven footnotes to the section on England, thirty-two are to works on geology or geomorphology and five only to articles of economic or historical interest. But though the amount of "human" geography included may be slight, it is linked in direct connection with the physical facts, and causal relations are frequently pointed out. The footnotes are supplemented by a general bibliography, the shortness of which is more to be explained by the poverty of general literature on the subject than by omissions on the author's part.

Some of the illustrations are disappointing: the orographical map of Scotland, marking heavily the highland areas of the Central Lowlands and Southern Uplands, while leaving blank the real Highlands, is very misleading, and in this and other maps the mixing of type, irregularly employed, the varying use of German and English forms of names, and the introduction of what seems unnecessary detail (*e.g.* "Gilling Gap" on the map of England) make for confusion. B. H.

Unknown Cornwall.— C. E. Vulliamy. (The County Series.) London: John Lane. 1925. 8½ × 7, pp. xii. + 246. *Illustrations.* 15*s. net.*

In these days of a swelling tide of tourist traffic to the West Country it seems almost fantastic to speak of the most attractive of all the counties of England as "Unknown Cornwall." Yet it is safe to affirm that of the thousands who cross the outskirts of the wild moorlands, and hurry noisily between them and the brink of the great granite ramparts seawards, not a hundred persons gain any clear notion of the real nature of the "unknown" land through which they speed.

The purpose of this volume is to unveil for us some of those characteristics of "Unknown Cornwall" which to a great degree set it apart from all the other counties of England: to reveal to us a land of primeval solitudes and of prehistoric monuments, with its cromlechs (locally "quoits"), stone circles and holed stones, its cliff castles and "beehive huts"—vestiges of a civilization so ancient and so mysterious in their origin and their import, that no one can tell us for certain by whom or for what purposes they were set up. Few things in our island are so profoundly impressive as these relics of a long-forgotten people scattered over the lonely moorland heights. Though the coasts further north and the Bodmin moors to the north-east have their own features of interest as parts of the "unknown Cornwall" with which the book deals, it is of West Penwith that the designation is primarily true and with which it is chiefly concerned. West Penwith, "The Land of the Three Seas," comprises the extreme portion of the "toe" of England, and lies south-west of a line drawn across from St. Ives to Penzance. The district is not more than 20 miles

by 7, but within it lie the majority of the ancient monuments in which Cornwall is richer than any other of the counties of England. Most of these are within 5 or 6 miles of Penzance, the Land's End, or the Gurnard's Head, and yet are unknown to and indeed unsuspected by the occupants of the fleets of char-a-bancs and the multitudes of motor cars that hurry by at a distance of but a mile or two away. It is still in the main a land primeval, and save for a narrow strip that man has hardly won from the wild, it is to-day practically what it was thousands of years ago. Mr. Vulliamy is right in observing that "Walking is the only way of getting to know this marvellous land." He has interesting and informing paragraphs on the ancient monuments and their origin, notably those on the more important, such as the stone circles on the Bodmin moors and in West Penwith. It is unfortunate, however, that in his descriptions of the characteristic features of the district and its remarkable remains he quite ignores the delightful and informing work of better-known writers like W. H. Hudson and J. C. Tregarthen. He doubts whether any traveller has ever walked round the Cornish coast from Marsland Mouth to Cawsand Bay. Here he is entirely ignoring the detailed journey described by Mr. A. G. Folliot Stokes in his pleasant book on 'The Cornish Coast and Moors,' a work which deals with nearly all the ground covered by Mr. Vulliamy in the region in question, and much more besides. Indeed, his attitude towards most other writers on his own subject, excepting Borlase and Carew, is the most unpleasing feature of his book, which is in itself also sufficiently marred by phrases such as "An urbanite in search of stimuli"; "he slides along on his tummy and tries to grab the plate," etc.

The book contains a number of drawings in colour and in the text by Mr. Charles Simpson. Some of the water colours of the former are of considerable merit, notably those of the "South Gate: Launceston" and "Lamorna Cove." The majority of the drawings in the text and of those (apparently) in chalk are disappointing and almost unrecognizable to one who has been familiar with the scenes themselves for over a quarter of a century of intimate wanderings among them. W. W.

Hampshire's Glorious Wilderness: Some Rambles and Reflections in and about the New Forest.— George R. Tweedie, J.P., F.C.S. London: Homeland Association, Ltd. 1925. 8 × 5, pp. 148. *Illustrations from Photographs by the Author, and a Map.*

It is to the credit of this little book, which is a faithful reflection of the author's impressions and experiences, that it makes no extravagant claims, yet makes one feel that if England as a whole ranks high as a beautiful country (where not disfigured by excessive industrialization) the New Forest district takes high rank within it. We are led into the depths of the woodlands where is many a famous oak and beech, over bracing upland heaths, down into swarthy moors, through little townships, and introduced to the ponies, pigs, and deer with all the diversity of elements that harmonize to give the district unity and charm. History is not neglected, and there are several interesting sidelights on the fell deed which Rufus Stones commemorates. The author is a little caustic at times, and rightly, about the people who dash through the Forest in motors, stopping to lunch at Beaulieu or Lyndhurst, and then think and say they know all about it. It would not be fair to criticize a work of such a modest compass for not discussing the more geographical relationships of the New Forest, but one could have wished for a recognition of one among the underlying secrets of its charm—that softness of the moist English climate, nowhere more strikingly displayed than in this south-west corner of Hampshire.

Where else along the fiftieth parallel in Europe does the frost let down the forest foliage so gently that it is often well in December before the carmine, russet, and gold of beech, oak, and elm have finally burnt themselves out?

L. C. W. B.

ASIA

Blue Tiger.— Harry R. Caldwell. London: Duckworth. 1925. 9 × 5½, pp. xiv. + 242. *Illustrated.* 15*s. net.*

This rather oddly named book is the record of twenty-four years of missionary life, chiefly in Southern China. Mr. Caldwell, one may be permitted to say, went about his work with a Bible in one hand and a rifle in the other—the latter being for any game he might encounter. The way in which he succeeded in employing his skill as a hunter to forward his work as a missionary is well told and very entertaining. Mr. Caldwell is a keen observer of nature, and has been able to get to the bottom of many Chinese superstitions about animals and birds. Among the game he has hunted, and of which he gives an account, are tiger, wapiti on the Mongolian borders, serow, and wild boar. The second half of his book is even more interesting at the present moment. It gives a vivid picture of the manufacturing of brigand bands out of the well-disposed populations, chiefly through the unscrupulous conduct of faction leaders and their troops. Having acted on several occasions as an intermediary between the military and the brigands, Mr. Caldwell came to appreciate both sides intimately, and his sympathies are almost always with the brigands. He is also able to give a first-hand account of recent troubles around Yenping.

AFRICA

The Lake Plateau Basin of the Nile.— H. E. Hurst, M.A., D.Sc. (Ministry of Public Works, Egypt, Physical Department Paper No. 21.) Cairo: Government Press. 1925. 11¼ × 7¾, pp. 75. *Map and Illustrations* (*some folding*). *P.T.*10.

About a century ago, when Mahommed Ali ordered the construction of the three great canals of the Delta which were to supply water for summer crops, especially cotton, he took the first step in the control of the water-supply of the Nile Basin which has led gradually to the elaborate schemes and the hydrographical researches of to-day. The last twenty years of the nineteenth century saw a great improvement in the organized irrigation of Egypt which has so marvellously increased the prosperity of the country, but accurate information of the regions of the Nile in the Sudan and on the Lake Plateau was lacking, except for the observations which had been made by travellers, missionaries, and traders. Some of these were of great value for the proper understanding of the interaction of the Blue and White Niles in flood-time, but they had mostly been lost sight of.

With the deliverance of the Sudan from Dervish rule the investigation of the hydrography of the Upper Nile Basin became possible, and a large amount of accurate information was gathered, and utilized for the provision of a more reliable description of its physical conditions than had been possible before. With the years immediately preceding the War, and more intensively since 1919, an era of systematic hydrological study of the Nile has dawned, with the result that the Nile is now one of the best-known rivers from the hydrologist's point of view.

This report of Dr. Hurst is the first publication of this last period, and it sets forth the information which has been accumulating, together with that which the author gathered during five months' tour—January to June 1924—on the

Lake Plateau. In it he discusses first the topography of the plateau area, in which are included the Great Lakes, the Semliki River, the Bahr el Gebel as far as Nimule, and the rivers and small lakes which form part of the drainage system. This description is usefully supplemented by some forty large photographs which very effectively illustrate the character of the vegetation, and show how important a part it must play in reducing the run-off in the shallow drainage lines and round the smaller lakes.

Two-thirds of the report deals with the hydrology, and here we have a much more complete and reliable collection of data than has hitherto been available; but Dr. Hurst rightly insists that this is only a beginning, and that regular and systematic work must be carried out over a number of years if those who will design schemes for the control of the waters of the Upper Nile in the future are to have adequate data for their purpose.

A good deal of information already exists on the amount and the distribution of rainfall, and a general increase of rainfall from south to north on the plateau is indicated, together with a very heavy rainfall over a part of the Kenya Highlands. But more information is needed, and a fuller knowledge of the run-off, the percentage of rainfall which reaches the lakes, would be of much value. Evaporation too has been but little studied hitherto, but the Department of Agriculture in Uganda is now taking up the matter.

The volume discharged from Lake Victoria at the Ripon Falls was measured in 1903, and again in 1923, when the lake-level was about 40 cm. lower. From a discussion of these measurements, and the lake-gauge readings, Dr. Hurst estimates the average discharge at from 560 to 740 cubic metres per second. Below the marshes of Lake Kioga this has been diminished to from 350 to 400 cubic metres, but at the exit from Lake Albert it has increased to from 700 to 900 cubic metres per second.

When we descend the Bahr el Gebel to Mongalla at the southern end of the marshes we find the average volume discharged by the Nile there to vary from 700 cubic metres per second in March to 1160 in September, which however has diminished to 430 to 500 cubic metres at the downstream end of the marshes. The increase of the low-stage supply for Egypt therefore depends on the possibility of diminishing this huge wastage of water in the marshy valley lines, and in regulating the level of Lake Albert. For either of these aims to be effectively achieved the early initiation of hydrological investigations is essential. We shall look forward to the appearance of further Nile Memoirs of this type.

H. G. LYONS.

South Africa: People, Places, and Problems.— William Harbutt Dawson. London: Longmans. 1925. 9 × 5½, pp. xi. + 448. *Illustrations.* 16*s. net.*

To write an adequate account of South Africa, its "people, places, and problems" in 444 octavo pages of fairly large type is a task of some difficulty. Obviously within such limits many details must be omitted. This Mr. Dawson has done, but he has succeeded in a marked degree in giving his readers a true impression of the country in broad outline, while the peculiar problems which confront its inhabitants, white and black, are set forth very fairly and with a praiseworthy, and largely successful, effort at impartiality. Into those thorny and highly controversial subjects we do not here intend to follow him, simply commending his treatment of them as worthy the serious attention of all interested in South Africa.

Mr. Dawson has a dark saying in his first chapter as to how very superficial

and " essentially geographical " is the knowledge of South Africa of normally well-informed people who have not visited the country. Whatever reproach he may intend to convey by the words quoted, the author shows that he attaches proper value to geographical factors. His description of the land as he saw it, travelling up and down the country and visiting, apparently, most of the places of note accessible by railway, is both vivid and accurate. The special attraction of coast lands, Karroo, and veld are all set forth, and the atmosphere proper to each is caught. Perhaps on the whole the impression is left that Nature is more kindly disposed to man's endeavours than she really is, in South Africa.

On the subject of communications Mr. Dawson pays a deserved tribute to the work accomplished by railway engineers, and praises the " skilful and progressive administration " of the lines. But he falls into a singular error—or has constructed his sentence clumsily—in writing that " when the constituent colonies were united in 1910 as the Union of South Africa one of the most important problems to be dealt with was the unification of the four government railway systems, and to the accomplishment of this arduous task Lord Milner (as he became later) brought his sound practical judgment and restless energy, with the most gratifying results." Milner was created a peer in 1901 and left South Africa in 1905. That he devoted much attention to the railway problem while Governor of the Transvaal is true, but unification was not then a live issue.

Rhodesia is not included in Mr. Dawson's survey, and to that extent his record is incomplete. The index might well have been better. F. R. C.

Life in French Congo.— Gabrielle M. Vassal. London: T. Fisher Unwin. 1925. 9 × 5¾, pp. 192. *Illustrations.* 12*s.* 6*d. net.*

Mme. Vassal accompanied her husband, the head of the Medical Service, on a tour of duty to French Equatorial Africa, and so saw much of the social life, general conditions, and opportunities for sport in the region around Brazzaville. Her book, on the whole, is a record of the shattering of one illusion after another. When she arrived at Brazzaville the sky was clouded and there was no sun—how different from the picture her imagination had painted! And then her house: no upper storey, no electricity, and no intelligent servants. It is little wonder that, with most pleasant recollections of life in French colonies in Eastern Asia, the sight moved her to tears. That was the beginning of the process of disillusionment. The servants proved on closer acquaintance to be even less capable than they appeared—it was like " running a house with children of six." Beyond the immediate circle of the house, she formed no more favourable impressions of the people or the country. To her both Europeans and natives seemed to be waging a fruitless struggle with the climate and with nature. The country, she writes, " depresses and deceives the new-comer till he has lost half his energy and hope "; and again, " One hears of things one never sees, and what one sees is always deceptive." It must not be thought from this that Mme. Vassal merely submitted passively to the environment. That this was far from being the case her hunting anecdotes well show. Equally, her energy and interest in her surroundings appear in her interesting account of the difficulties attending the innoculation of native populations against sleeping sickness, a task in which she assisted her husband. There is also much of interest on social life in the larger settlements, and on the relations between whites and natives. She writes effectively and generally light-heartedly, but the general impression of her visit is unmistakable.

Sur les Côtes du Sénégal et de la Guinée : Voyage du "Chevigné."— J. Rouch. Paris : Société des Editions Géographiques, etc. 1925. 10½ × 8, pp. 184. *Sketch-maps and Illustrations.* 20 *frs.*

Shortly before the war Capt. J. Rouch was given command of a hydrographic expedition despatched by the French Government to survey the rivers and creeks of Senegal and French Guinea. The scientific results of the expedition were published on its return.

The volume under review is an account of the personal experiences of its commander, and contains little of geographical interest. The voyage appears to have been singularly uneventful, and the reader cannot but wonder why Capt. Rouch, who is the author of several scientific works, troubled to publish such a trifling book. The picture he draws of the social life of French officials on the West Coast is most unpleasant and, we feel sure, is an injustice to his fellow-countrymen. The book is copiously illustrated with photographs, and contains three somewhat rough sketch-maps. E. W. B.

AMERICA

The Glittering Mountains of Canada: A Record of Exploration and Pioneer Ascents in the Canadian Rockies, 1914–1924.— J. Monroe Thorington. Philadelphia, Pa. : John W. Lea. 1925. 9 × 6, pp. xxii. + 310. *Maps, Portraits, and Illustrations.* $4.50.

Dr. J. Monroe Thorington's book does not deal with mountaineering only, but is also a record of travel and exploration. He gives an excellent account of all the early " Voyageurs " or the fur traders of a century ago, also of some other travellers who between 1846 and 1852 visited the Rocky Mountains of Canada. The historical material has been collected with much painstaking research from all possible sources. Two whole chapters are devoted to the various accounts of those early travellers, who penetrated into the wilds of this mountainous region in Western Canada. These men were in the employ of the North-West Company. Some, like David Thompson, were well-educated men, who kept a regular diary, and always travelled with a sextant, chronometer, and barometer. David Douglas was another : he it was who in 1827 named the two peaks Mount Brown and Mount Hooker that for over seventy years masqueraded as the two highest mountains in the North American Continent. These men were the pioneers who supplied the outlines of geographical knowledge. Later, in the 'eighties of last century, when the Canadian Pacific Railway connected Montreal with Vancouver, a new era opened. There were still vast regions of the Rocky Mountains unexplored, and it was not till the early 'nineties that mountaineers first visited these inner fastnesses. Dr. Thorington's time came later, after exploration was almost finished. Trails were well marked, and the routes to the various groups of mountains were known. Serious mountaineering could therefore be attempted. Dr. Thorington has made good use of his time. During the last ten years he has been actively interested in the icefields at the sources of the Athabasca and Saskatchewan rivers. He has visited all the important groups of mountains that lie between the Canadian Pacific Railway and the Canadian National Railway, more than 100 miles further north. Icefields have been crossed, and many of the finest and highest mountains climbed for the first time: Mount Hooker, the North Twin, Mount Saskatchewan, and others. The North Twin is the third highest summit in the Canadian Rocky Mountains, only Mount Robson and Mount Columbia being higher.

Although necessarily most of the book is concerned with mountaineering,

there are several chapters of exceptional interest dealing with the Athabasca Pass, and the "Voyageurs" of a century ago. For the first time all available information has been collected from the diaries and letters of these fur-hunters and trappers. Extracts from their diaries are given, and also portraits of several of the early pioneers. A journey across the Athabasca Pass in those days was a serious undertaking, and one would not expect extensive diaries to be kept, yet some still exist, and that of David Douglas gives an excellent description of the Athabasca Pass. His two mountains, Mount Brown and Mount Hooker, that he thought to reach 16,000–17,000 feet, have fallen from their high estate, and the maps and geography books of one's youth are now known to be inaccurate. Mount Hooker is only 10,872 feet, and Mount Brown 9156 feet. Although Mount Hooker no longer counts as the highest mountain in North America, it is the proud possessor of a different kind of record. Dr. Thorington and his party were out for fifty-four hours—two nights and nearly three days—on the occasion when they climbed to its summit. As Dr. Thorington says, "In fact, it turned out to be something of an endurance record for a Canadian climb—a record that we have since been told we are quite welcome to."

The book is delightfully written. We are not given pages of minute description of the mountaineering: history, geography, and local colour are well represented. There are excellent photographs, several maps, a good index, and at the end of the book a series of valuable appendices. To conclude with what Dr. Thorington begins with on the first page of his book: "There is told, in the North-West, the story of an old prospector of whom, returning home after many years, it was asked what he had to show as the equivalent of so much lost time; and he answered only, 'I have seen the Rocky Mountains.'"

J. N. C.

Californian Voyages, 1539–1541. Translation of original documents edited by **Henry R. Wagner.** San Francisco: John Howell. 1925. 10 × 7, pp. 100. *Map Reproductions.*

The expedition under Francisco de Ulloa, which first demonstrated that California was a peninsula, and approximately charted its coast-line, has chiefly been known from second-hand accounts in Gomara and Ramusio. Neither of these throw any light upon Ulloa's ultimate fate. There exists, however, a manuscript giving an account of the earlier part of the voyage which has up to the present been attributed to one Pedro de Palencia. Mr. Wagner shows that it is actually a copy of a report on the expedition by Ulloa himself, sent to Cortes, by whom he had been sent out, Palencia being merely a witness. Ulloa describes in detail his voyage up the Sinaloa and Sonora coast to the mouth of the Colorado, and then south and north around the peninsula. From his remarks upon Cape San Lucas, its southern extremity, and upon the bay in the vicinity of Cape Tosco, it is apparent that this portion of California was known to the Spaniards before Ulloa's voyage. In this connection it may be noted that of fifty-six "relations" dealing with Cortes' own voyage, made just before Ulloa's, about half refer to California as "isla," while the other half use the name California. The expedition had left Acapulco in July 1539, and had reached Cedros Island in April following, whence one of the vessels returned, carrying back Ulloa's report. That Ulloa himself eventually returned Mr. Wagner believes can be shown from circumstantial evidence. The maps he reproduces show the gradual growth of knowledge of the peninsula. A MS. map in the Archives of the Indies in Seville, believed to have

been attached to Cortes' acts of possession, and probably executed in 1537, shows the southern extremity of Lower California "in the air." He also reproduces a section of the Cabot planisphere, which uses Ulloa's nomenclature in the main, and a MS. map probably drawn by Battista Agnese in 1543, which may be the first to show the peninsula of California. Mr. Wagner adds brief accounts of two subsequent voyages, by Hernando de Alarcon in 1540, and Francisco de Bolaños in 1541 or 1542, which seem to have added little to the accurate cartography of the area. All the accounts have been carefully edited, and identifications of localities are supplied.

AUSTRALIA AND PACIFIC ISLANDS

Across Unknown Australia.— Michael Terry. London: Herbert Jenkins, Ltd. 1925. Pp. 311. *Illustrations and Sketch-map.* 15*s. net.*

The value of this book is due to two factors: the interest always attaching to genuine adventure, lightly and easily described, and the importance of the region selected for a decidedly risky experiment. The author would readily agree that the real significance of his story lies in its background, the physical features observed and their promise for the progress of Australia. Every one who brings us into intimate contact with any section of the northern areas of the continent should be sure of a full audience. Finding himself in Queensland in 1923, Mr. Terry decided to make an attempt, with a trustworthy companion, to cross from east to west in a motor-car. Without claiming to be an explorer in the strict sense, he followed an impulse "to wander afield ahead of the crowd." A ten-year old Ford, picked up at a cost of £50, hardly seemed an adequate means of transport over more than 2000 miles of country. Nevertheless, one follows her fortunes with interest during a rough-and-tumble expedition lasting eight months. The climax came when the car was sold at Broome, in Western Australia, for £100.

A defect of the book is the lack of a good map, for the sketch provided, measuring only 6 by 3½ inches, prevents the reader from realizing the considerable extent to which the country traversed is already occupied for pastoral purposes. It is necessary to have recourse to a good atlas to follow closely, as is worth doing, the line of country along which the car was taken. Many important names, mentioned in the text, are crowded out of the sketch. On the other hand, the illustrations, forty in number, are excellent, and combine well with the rich local atmosphere supplied in the text.

Australia has always yielded her secrets to man grudgingly, as if wishing to test his enterprise and endurance to the utmost, and from Dampier's time on, her north-west coasts have afforded a good example of this attitude. Development has, of course, been going on for years, but rather slowly. Cattlemen have led the way, and prospectors have done their share. Recognizing the growing importance of that country, the Royal Geographical Society gave Mr. Terry an opportunity to state the position as he saw it on his journey. This was in May, 1924, and the report of the meeting appeared in the *Journal* for the following July. Certain recent forward movements, showing the determination of the Commonwealth Government to grapple more closely with the difficult problem of the Northern Territory, give Mr. Terry's work a special significance, which he may not, perhaps, have anticipated when he set about his task. In the north a railway extension of 158 miles, referred to in the book, is under construction from Katherine to Daly Waters. This is to cost 1½ million sterling. In the south an extension

of 250 miles, Oodnadatta to Alice Springs, is to be initiated this year. The intervening gap of 800 miles, between Alice Springs and Daly Waters, completing a North-South Continental Railway, must be taken in hand at a not distant future. Perhaps the most interesting of recent happenings is the proposal of the Commonwealth Government to divide the Northern Territory into two parts, with the 20th degree of latitude as their boundary-line. A commission of three members, with Darwin as headquarters, is to carry out extensive public works in the northern section, which is to be called North Australia. Two other railways, one from Katherine to Wyndham, the other from Daly Waters to Camooweal, have been favourably considered, but they will probably have to wait awhile. R. W. G.

Papua of To-day; or, An Australian Colony in the Making.— Sir Hubert Murray. London: P. S. King & Co. 1925. 9 × 5½, pp. xvi. + 308. *Map, Sketch-maps, and Illustrations.* 21*s. net.*

The author of this interesting and authoritative work is well known as one of the foremost of the native administrators in the Empire. His previous publications on the native races and "weaker peoples," and his sympathetic treatment of the policy to be pursued in dealing with them, have already established his reputation, and make a special appeal to persons like the reviewer, whose lot has been so largely cast in similar work in tropical lands. Papua, or New Guinea, like Borneo, is one of the largest islands in the world, being indeed the largest, if Australia and Greenland are excepted. Like Borneo, its not-far-distant neighbour to the west, it has mighty mountains, many rising to a height of over 10,000 feet and several to over 13,000 feet. Much has still to be done in the way of detailed exploration, and Sir Hubert Murray's chapters on the country and its exploration will provide food for the ambitions of young explorers who may be afraid that there are no more worlds to conquer in that uncomfortable though alluring field. For instance, Mr. Jackson in one of his expeditions had to camp for three nights at an altitude of 9000 to 10,000 feet, and found the cold so intense that in order to get any sleep he had to burn low fires under the middle and foot of his bunk, notwithstanding the fact that he wore three pairs of woollen socks, two pairs of underpants, and a pair of trousers, two heavy undershirts, and a flannel shirt, with a rug and blanket over him and two rugs underneath. And this was within a few degrees of the equator!

The administration of Papua was taken over by the Commonwealth in 1906 after excellent spade work had been done under the Crown Colony Administrators, Sir William McGregor and Sir George Le Hunte. The task has been increased by the addition of the German Mandated Territory, and thus the Commonwealth is responsible for a good half of the island, the other or western half belonging to Holland. That the task will be well and sympathetically performed by Australia can be confidently assumed from the account of its stewardship given in this volume by Sir Hubert. The principles underlying the administration of such territories, the difficulties of dealing with primitive peoples, the characteristics due to the special environment and the isolation of their numerous and discordant tribes, and the lessons to be gathered from experiments and experience in other parts of the world come under review and provide a storehouse of information and guidance for future administrators that should prove invaluable.

There are many questions raised by the author that might well be dealt

with in this review did space permit. The origin of these Papuan tribes, and the nature and relation of their dialects or languages, the strangeness of some of their primitive customs, as well as the variations in their physique, provide ample scope for interesting and scientific treatment. For instance, Sir Hubert Murray says that however much the natives of Papua may differ among themselves, they agree in having little or no resemblance to the semi-civilized inhabitants, *e.g.*, of India, Ceylon, or Java. The population of Papua is still in the Stone Age, and a generation ago was in a state of barbarism. We naturally ask, then, where did they come from? And why are they so far behind in the scale of civilization compared with the Maoris on the south or the Borneans to the north?

The much-discussed problem of the influence of the European and his civilization is also raised. Head-hunting and tribal warfare kept the natives at least "fit" with some glow of excitement in their lives. The transfer from such or similar activities to working for planters on cotton or copra settlements at 4*d*. per day can hardly be looked upon as offering an inspiring or exciting substitute for their former free life. It is pleasing however to gather that the moral and social influence of Christian Missions, apart from the question of theological dogma, is enormous, and largely supplies, on a higher plane, an outlet for the energies formerly devoted to barbaric customs and rites.

A note of warning is sounded by Sir Hubert in reference to the general idea that the country is possessed of "teeming wealth" and will "grow anything." The absence of cereals for native food supply, the mountainous nature of much of the country, and other disadvantages, such as the absence of what the author calls an "intermediate race" (such as the Chinese) to work the somewhat poor soil, prevent a rush for exploitation, but the country has great possibilities for Australia and the Empire.

The author says that no account of Papua would be complete without some reference to cannibalism. It is now practically extinct, but, to quote Sir Hubert, "it is not difficult to get old men talking about cannibalism when you have once gained their confidence and they are sure that you are not going to send them to jail, and in many cases they will talk of the killing and cooking of a man just as they would of the chase of an animal; and they will discuss the merits of human flesh as food just as they would talk of fish or pig. Occasionally you find a man who does not like it, and he simply does not eat it; he does not seem bound by any ritual to join in the feast against his will.

"'The women liked babies too much,' an old friend of mine at Iasi Iasi told me once, 'and if we came back without babies for them to eat they would not let us into the village.' A grown man, he admitted, was rather tough, but a baby was delicious. But Komitoba, of Huvivi, in the Northern Division, would not agree to this. 'Your friend at Iasi Iasi was no cook,' he told me. 'If you cook a man on an open fire, I admit he will be tough, but cooked on hot stones and covered with leaves, the stringiest old man is tender. Why should he be any tougher than a bush pig?'"

An excellent book, to be commended to administrators and anthropologists, as well as to the man in the street. C. H.

The Tasmanian Environment.— **Gordon L. Wood.** Adelaide: Rigby, Ltd. 1923. 8½ × 5½, pp. 102. *Maps and Illustrations.*

This text-book has many features to recommend it, and succeeds in its purpose of emphasizing the human side of the geography of Tasmania. Among the best sections are (1) those on the physiography and the climatic conditions,

closely based on Professor Griffith Taylor's accounts and very well illustrated; and (2) that on population with its subdivision into what are, in effect, the natural economic divisions. Less satisfactory is the chapter on the geological conditions, which seems to attempt the impossible (and at the same time the unnecessary) in summarizing in five to six pages the complete geological history of the country.

In contrast to the general excellence of the illustrations, it is surprising to note the deficiencies of the chief topographical map: it is inserted, without obvious connection, in the chapter on vegetation, is badly cut by the binding, has unnumbered contour lines, and is without any key. B. H.

MATHEMATICAL AND PHYSICAL GEOGRAPHY

Notes sur la Variabilité des Climats.— Documents Lyonnais, études de climatologie. Première partie. Introduction générale historique. **Jean Mascart.** Lyon: Audin et Compagnie. 1925. $9\frac{1}{2} \times 6\frac{1}{2}$, pp. 382. 25 *frs.*

This book is apparently intended as a general introduction to a study of the meteorological and quasi-meteorological data for Lyons, with a view to elucidating the variations which have taken place from time to time in the climate of that city. Its scope is very wide: beginning with a study of the causes of climatic changes on the geological scale, it ranges over the whole of a very vexed field—relations of various elements with sunspots, lunar cycles, magnetic changes, and meteorological periodicities of all lengths. From this vast study practically nothing emerges; the reader who perseveres to the end is left with an impression of extraordinary futility. M. Jean Mascart seems to have read enormously, and finding that almost every statement made by one author is contradicted by another author, he struggles in a morass of doubt without a single secure foothold. Thus the relation between sunspots and solar radiation is discussed on several widely separated pages, with results which vary as widely, and even the thirty-five-year Brückner cycle is open to doubt. The confusion inherent in the original material is increased by the lack of sufficient system in the arrangement of the sections, and by the author's practice of mixing up a summary of the work of another with a running commentary of his own, and the reader heartily endorses the lament on p. 202, "Alas! from so many many publications, curious remarks, singular coincidences, there remains nothing to-day but an impalpable smoke." Although he can make nothing of the past literature, the author emerges with a clear conception of the nature of the problem, which "reduces itself to two factors: first, the study of the solar radiation; and secondly, that of the changes of a meteorological nature which this variation introduces into the different regions of the globe." For this purpose we need long series of homogeneous data. The book concludes with a valuable but somewhat unsystematic bibliography of sixty-three pages. There are a few slips, as on page 356, where a well-known South African professor is alluded to as Miss Schwartz. C. E. P. B.

GENERAL

The Book of the Red Deer and Empire Big Game.— Edited by **John Ross** and **Hugh Gunn.** London: Simpkin, Marshall, Hamilton, Kent & Co., Ltd. 1925. $8\frac{1}{2} \times 11$, pp. 339. *Many Illustrations.* 42*s. net.*

This admirably produced and magnificently illustrated volume will be prized by all lovers of British forest sport. Major Ross tells us that his first conception of the work was that it should be devoted exclusively to the red

deer of Scotland; at Lord Morris's suggestion its scope was widened so as to include the caribou of Newfoundland and the members of the deer family in other parts of the Empire; and it was finally decided, in order to have the Empire fully represented, that other aspects of big-game hunting should be depicted as well. The aid of distinguished authorities was secured, and the result is a symposium of information regarding the deer and other game such as has rarely been found within the covers of a single volume. In a brief review it is impossible to do more than indicate the value and interest of the contents. The subject of the red deer is treated from every angle. Mr. Ludovic Mann contributes an erudite article on the deer "in the morning of the world"; Mr. Alexander Patience writes of ancient deerstalkers; Mr. George Eyre-Todd describes some royal hunters; Professor W. J. Watson traces the history of the deer and the boar in Gaelic literature; Sir Iain Colquhoun discusses the future of deerstalking; while from the pen of Major Ross himself comes an article on deerstalking in the Scottish Highlands that will bring back to many a hunter the memory of days spent among the heather-clad hills when, even if a shot missed, the quest was not in vain. May one however, without being ungracious, suggest to the gallant editor that there are no jungles in Cathay?

The second part of the book, for whose editing Colonel Hugh Gunn is responsible, contains varied and interesting articles on big-game shooting all over the world, including the Canadian Rockies, India, Australia and New Zealand; Dr. Charles Hose contributing an account of the deer and other game in Malaysia; and Colonel Gunn showing the sportsman as Empire builder. The true spirit of the hunter is the chain on which these articles are hung; the spirit which, as Major Ross says, values the trophy for the memories of the struggle and the toil to secure it. The book is being produced also in two separate parts, price half a guinea each, but even those who pay two guineas for the handsome *édition de luxe* will have the satisfaction of knowing that all profits are to be handed over to the "Blighty" Scheme for Disabled Men.

O. R.

THE MONTHLY RECORD

EUROPE

The Manchester Plain.

THE close connection between geological conditions and human settlement is demonstrated in two papers contributed to the *Journal* of the Manchester Geographical Society, vols. **39–40**, pts. i.–iv., 1923–4. In the first, Professor O. T. Jones deals with the origin of the Manchester Plain. The limestones, millstone grits, and coal-measures of the Southern Pennines were laid down during the Carboniferous era. After being elevated into an upland basin, they were subjected at the close of the era to considerable erosion, and finally reduced to an almost level plain, upon which were spread New Red Sandstone deposits. Still later, marls and rock salts were laid down, and further Lias formations, when the area was once more below sea-level. The plain was finally differentiated from the mountains at the beginning of the Tertiary Era, when extensive crustal movements, correlated with the volcanic activity in North-West England and Northern Ireland, produced a series of folds which included the Pennine Chain. The drainage system must therefore

date from this period: the existence of a rejuvenated river system shows that a further slight uplift must have taken place during this era, possibly in the Miocene or early Pliocene Period. The events of the Glacial epoch have had a profound influence upon the area. At the maximum the whole plain was covered by the ice, which also extended high up the flanks of the Pennines. The Boulder clay covering was formed by the ground moraines of the ice, and sand and gravel were also deposited. When the sheet began to withdraw, the drainage flowed between the ice and the flanking Pennines, cutting notches through the spurs: as the ice-level fell, these notches were repeated lower down the slopes. At the same time, the ice dammed up the pre-glacial valleys and formed lakes. While the ice-level was high the drainage was to the east of the Pennines: later a great ice lake was formed on the Cheshire Plain, which, incidentally, assisted in the excavation of the Ironbridge gorge of the Severn. As the sheet retreated and the level fell, this lake was split into a series, separated by the north-westerly ridges of drift. Some of the channels connecting these lakes afterwards formed portions of the river systems. Finally, the lakes were drained off, and the rivers resumed their westerly flow, though not always in their former beds.

In the Manchester district, the Mersey meanders through an alluvial plain. Where it emerges from the rock gorge below Stockport, three distinct river-terraces may be observed. The Didsbury high terrace is about 25 feet above the alluvial plain, and between them are traces of others in the glacial deposits at 10 and 15 feet. The high terrace was evidently formed by a heavily loaded river, which became "braided." Between the resulting river plains of the Mersey and Irwell and the glacial deposits there would be a trough, and in this trough were formed the characteristic "mosses" of the district. After the formation of the high terrace renewed excavation took place, due probably, though not necessarily or entirely, to an uplift, during which the middle terraces were deposited. The valleys of tributaries then cut up the "mosses" into their present form. The latest occurrence in the geological history of this area was a subsidence which has caused the silting up and flooding of the rivers.

The effect of this geological history upon human settlement is clearly shown in a subsequent paper by Mr. H. W. Ogden. Village sites have been chiefly determined by the presence of water. The Boulder clay being thick, compact, and impervious, the villages are generally found on the sand and gravel deposits. These occur in three kinds of localities: (1) on the high mass deposited on the flanks of the Pennines while the drainage was still to the east (as at Macclesfield); (2) on the succession of ridges deposited at each fall in the level of the ice: here villages occur with "moss lands" between; (3) around the edges of the great deltaic masses left by the lakes when they drained through the Delamere valley in the north and the Beeston Gap in the south. Here the villages are placed along the line of springs between the gravel deposits and the boulder clay. Other sites occur on the parallel lines of Bunter sandstones to the west and along the river terraces. The direction of the latter is north-west, so that, with the villages on glacial deposits running north-east, the general pattern is a criss-cross. To this must be added the communities of the salt area, and the bridge-heads and trading centres of Warrington, Nantwich, Stockport, Chester, and, later, Liverpool.

German Topographical Surveys in the Sixteenth Century.

The beginnings of Topographical Survey in the various European countries have never been comprehensively dealt with, and the subject well

deserves the attention of students of cartographical history. To deal at all adequately with the whole subject at once would be a very big task, but if the history were taken up by competent authorities for the different countries separately, it might be more easily compassed. The material for such a history of early survey in Germany appears to be already fairly adequate, to judge from an interesting article by Dr. Hans Beschorner in the *Mitteilungen* of the Dresden Geographical Society for 1924 (issued February 1925). The special subject of the article is the survey of Saxony towards the end of the seventeenth century by Matthias Öder and his collaborators, but the writer begins with a valuable sketch of the general course of survey work in Germany at the time, particularly useful being the references to earlier literature on the subject (some dating back to the eighteenth century) much of which is buried in the transactions of local societies (historical, etc.), and thus little known outside Germany.

Apart from outstanding figures like Philip Apianus (whose survey of Bavaria is generally recognized as one of the most remarkable pieces of work of the kind before the coming of precise survey methods), the very names of the individual workers are quite unfamiliar, yet some of their results were surprisingly good for the time. In 1561 a map of Silesia on the scale of about 1/530,000 resulted from the three years' work of Martin Helwig, Rector of the Breslau Gymnasium, and it formed the basis of all maps of the district for nearly a century. The map of Pomerania was taken in hand by another schoolman, Prof. Eilhard Lübben of Stettin, commissioned thereto by Duke Philip. He took nearly 6000 observations from 156 stations, and the map was engraved about 1614 by N. Geilkerken of Amsterdam on twelve plates on the scale of 1/200,000, though the Thirty Years' War prevented its publication. Helped by two mathematicians of Königsberg, Caspar Hennenberger produced in 1576 a woodcut map of Old Prussia in nine sheets on the scale of 1/400,000, on the basis of seven years' work in the field. Apianus' survey of Bavaria was spoken of in the *Journal*, vol. 24, p. 675, to which reference may be made for details. In 1596 George Gadner presented to Duke Frederick I. his "Chorographie des Herzogtums Württemberg," finely drawn on twenty-nine sheets of parchment, on the scale of 1/48,000. A map of Alsace had been completed in 1576 by Daniel Specklin on a scale varying from 1/184,000 to 1/191,000, being different for latitude and longitude. Although marred by this and some other defects, the map was nevertheless an important production. Matthias Öder's map of Saxony may have owed something to Apianus, considering the close relations with Saxony maintained by the latter's family. A survey had been begun at the instance of Prince August by the Leipzig Professor Johann Hommel, after whose death in 1562 the work was continued by the two younger sons (Georg and Matthias) of George Öder the Elder of Annaberg, himself a surveyor. Georg (the younger) retired from the undertaking in 1575, and his brother's chief assistant was thenceforth a relative named Zimmermann. They based their work on a series of astronomical determinations, the detail being filled in by field operations with measuring tape, quadrant, and compass. The rough field-sheets were afterwards combined into a "Landtafel" on the scale of 1/12,500, which though covering less than half Saxony measures in all 38 square metres. After the death of Matthias Öder in 1614, the operations were continued by Zimmermann. The writer thinks that the merit of this survey, carried out with more or less imperfect instruments, has not been sufficiently recognized. The study ends with notes on surveys of a rather later date, including Schickhart's of Württemberg.

ASIA

The Andaman Sea.

As the first of a series of studies to be devoted to the physical conditions of the seas round India, Major R. B. S. Sewell has contributed to the *Memoirs of the Asiatic Society of Bengal* a valuable paper on the Geography of the Andaman Sea basin. The western boundary of the sea is a lofty submarine mountain chain of which only the topmost peaks appear above the surface, the ridge being broken by channels connecting the Andaman Sea with the Bay of Bengal. This chain forms a southward loop from the great Alpine-Himalayan System, which is prolonged into Sumatra, Java, and other islands of the Malay Archipelago. The two main geologic formations—conglomerates and sandstones on the one hand, clays and clay-marls on the other—point to two phases of upheaval along this line, the first dating from the Early Tertiary, or even earlier, while the clays associated with the second were probably deposited during the Miocene. The Andaman ridge is a continuation of the westernmost of the three Burmese tectonic zones, but, like the bed of the Andaman Sea to the east, it has suffered depression since its first formation to the extent of perhaps 8000 feet. Originally the area occupied by the sea seems to have had the character of a large brackish-water lake, extending well up into Burma, but while the northern part has since been raised, the central part of the basin has been depressed. By collating all the available soundings, Major Sewell has constructed a bathymetric chart of the sea, which shows at once that it does not form a simple basin, but that in the north-west there are two smaller and shallower, but quite independent basins, separated from the main basin by a secondary ridge running through Flat rock and Barren island. This ridge is volcanic, and its continuation is to be found on the line separating the Irrawaddy and Sitang valleys. To the south the two ranges become blended, and the contours are extraordinarily complicated. To the east there is a series of submarine peaks, probably volcanic, which seem to be continued in the volcanic range of Eastern Sumatra. The greater number occur in association with the deep channels connecting the Andaman Sea with the Bay of Bengal, and there is reason to think that these channels represent transverse fractures of the range. To the west a second line of elevation is separated from the main ridge by the fairly deep channel of Investigator Deep. Evidence of a recent rise of land-level (or possibly depression of sea-level) exists in raised coral banks in certain parts of the Andaman group. Each of the three main portions of the Andaman–Nicobar ridge is surrounded by a typical "continental shelf," which, in view of the great changes of level that have taken place, seems to have arisen as a comparatively recent formation from the wear of the land and the outward growth of coral banks. The shelf is much wider in the west than in the east, and coral banks and islands are also found chiefly in the west, possibly due to the influx of oceanic water during the south-west monsoon. They seem to constitute a real barrier reef, and to account for its formation Major Sewell adopts a suggestion of Molengraaf's in regard to similar features in the Malay Archipelago, namely, that there has been a shifting of the axis of the Andaman Anticline whereby the eastern slope has been steepened and raised, the western flattened and depressed. Finally, he shows that the main tectonic features of this area are probably due to the same series of folds and depressions as in Molengraaf's view have given rise to the ridges and troughs of the Archipelago.

AFRICA

Levelling in French West Africa.

The energetic Director of Surveys in French West Africa, Commandant E. de Martonne, has put forward a project for a general levelling in that part of the French dominions, which is outlined in the *Bulletin du Comité d'Etudes historiques et scientifiques* for April–June, 1925. After some general remarks for the benefit of the layman on principles and methods of levelling, the writer points out the practical importance of a correct knowledge of relief for public works and economic development of all kinds—railways, roads, canals, irrigation works, water-power installations, and so on. An examination in detail of the several kinds of levelling operations yet carried out in French West Africa shows their entire insufficiency to supply the above needs. Here and there a certain amount of precise work has been done, it is true, but the main defect of this is the lack of coordination. Even the railway surveys have been carried out in a fragmentary way, at different times, by different methods, and with different departures. Moreover, there has been no closure of circuits, so that an error of several metres may be possible at the end of a line 1300 kilometres long. The less precise method of zenithal observations, carried out exclusively in Senegal and Guinea, gives in practice results much inferior to those postulated theoretically, and the error may reach 10 metres for points of the first order at a distance of 500 kilometres from the coast. The little reliance to be placed on the results of barometric levelling is shown by a comparison of the figures obtained for the same station by different observers. Thus the value for the altitude of Wagadugu, the capital of the Haute-Volta, varies from 244 to 325 metres, and for Lake Chad from 240 to 295 metres, and elsewhere the uncertainty amounts to as much as 30 or 40 per cent. Commandant de Martonne dwells on the local advantages to be gained from a general levelling, and outlines a scheme of operations which he considers perfectly feasible at the present moment. A large number of competent officers are already engaged in work of the kind in different parts of the territory, and he urges that a number of these should instead be concentrated on the general scheme. The operations of the first urgency would consist of the carrying of a series of main lines through the several colonies to meet at one or more central points in the interior. Bamako is indicated as the most important centre of the kind, on which main lines would converge from Dakar, Conakry, and Grand Bassam respectively, following a railway throughout in the first case, and for a considerable part of the whole distance in the other two. By combining forces in the way suggested he thinks that the field-work for this could be completed in four months.

AMERICA

The Tract between the Xingu and Tapajos Rivers, Amazon Basin.

A detailed description of the rivers Iriri and Curua, and the surrounding country, is contributed by Miss E. Snethlage to the *Zeitschrift* of the Berlin Geographical Society, Nos. 9–10, 1925. The Iriri, into which the Curua flows, is a tributary of the Xingu, itself one of the main southern tributaries of the Amazon. Miss Snethlage had made a journey through this practically unknown region in 1909 (see *Journal*, 44, 100), but the present paper appears to be based also upon a further journey in 1914, and even later work. The upper courses of these rivers are practically south to north, and one characteristic is the successive unions of roughly equal-sized rivers to form the main stream, *e.g.* the Rio Novo Iriri and the Iriri, the Iriri and the Curua. The upper courses are smooth-flowing, though very winding, but the middle and lower, especially

of the Iriri, are broken by numerous falls and rapids. Another feature is the large number of lakes; in the lower course of the Iriri these are merely produced by an expansion of the river-bed; but above the junction with the Curua, when the alluvial valley widens, the lakes occur to one side of the river in the forest, which may be evidence of a former higher level of the Amazon system. On leaving the Amazon plains in the widest sense, low highlands are encountered which never rise above 200 metres. These are of sedimentary rocks, and a characteristic feature of the landscape is their long straight edges. At or about the junction of the Iriri with the Xingu these are succeeded by irregular groups of round-topped hills, probably of primitive rocks, with Para sandstones on their flanks. These chains continue on either side of the Iriri at some little distance, and appear to be only the edge of a highland of primitive rocks, broken up by the rivers into separate blocks. These hills terminate at the Serra Ernesto Accioly on the upper Iriri, where the much-discussed plateau of Brazil may begin, though no signs of a plateau can be seen in the restricted view from the river. Similarly, the writer is unable to say whether the Salto do Cachimbo on the Curua marks the descent of the river from the plateau, or is merely a break through an isolated Serra. The highest point reached on the Iriri was only 250 metres above sea-level by aneroid; the Serra do Cachimbo probably rises to 600 metres.

On the Iriri at the end of June transitional weather was experienced, with daily storms and a temperature comparable to that of Para. In July the rainstorms decreased, and August had perfect weather. From October onwards there was much rain, especially at nights. The rivers are thus highest from January to March. In 1914, though there was higher water at the Curua–Iriri junction than in September 1909, the Iriri farther down was very low, and no rain had fallen by December.

Miss Snethlage gives a detailed description of the luxurious vegetation and fauna of this area, the distribution of the various species of palm (the Mauritius palm was encountered in the upper courses), of the begonias, orchids, and other blooms, and particularly of the rubber trees (the *Hevea brasiliensis* and *Castilloa*) and the Brazil nuts (*Bertholletia excelsa*). Her notes on the population, Indian and civilized, are somewhat indefinite, through the lapse of time and its particularly transitory character. The largest settlement is Sta. Julia, on the Iriri above its junction with the Xingu: this controls the river traffic, and its population including Indians numbers several hundreds. Another centre which owes its importance to similar causes is at the junction of the Curua and Iriri (Bocca do Curua). The less permanent settlements are classified as Barracões, the residences of the officials of the estates, and distributing centres for manufactured and other imported goods; Seringueiros, the dwellings of the rubber collectors, often on islands, and in the centre of a network of paths (Estrada) leading to the trees; and Caucheros, large sheds generally on the banks, the headquarters of large bodies of collectors, who return each week with their harvest. These settlements vary, of course, with the state of the rubber market.

AUSTRALASIA AND PACIFIC ISLANDS

Australian Settlement.

In continuation and amplification of his studies in Australian settlement, Dr. Griffith Taylor contributes a paper, "The Frontiers of Settlement in Australia," to the *Geographical Review* for January 1926. His previous work was analyzed in the *Geogr. Jour.*, **64**, p. 131. The well-known concentration of the population in the coastal lands of the south-east is re-emphasized by

diagrams and figures. By comparing the areas with a density of population of one person per 4 square miles for the last three censuses, it is seen that on the whole no extension has taken place, notwithstanding that the total population has increased by 1½ millions. Further, of the 2 millions of rural population only 6 per cent. dwell in these "sparse lands." If the 10-inch isohyet is drawn across the south and combined with the line of division between the eastern and central states, the continent is divided roughly into two equal areas: yet that lying north and west of these lines contains only one-third of 1 per cent. of the total population. What will be the future of this half of the continent? The writer believes, after careful examination, that in any case two large areas must be regarded as absolute desert: the "Arunta" desert of 60,000 square miles in the east, and the western desert of 440,000 square miles. The marginal regions are at present very sparsely settled: in the North-West Division of Western Australia, for example, where practically all the land is held on pastoral lease, approximately fourteen sheep are supported per square mile. The 800-miles stock route from Hall's Creek to Wiluna has only twice been used since opened up. Dr. Taylor attacks the practice of comparing Australia with the United States, and expecting a similar development. Roughly equal in area, the United States has five times as much temperate land with a rainfall over 20 inches, and only one-fifth as much arid land with less than 10 inches. For the Northern Territory, he believes the proper comparison to be with Nigeria, and sees there a future for millets and industrial cotton. The further conception of this territory as partly an area of tropical growth, is based on another mistaken comparison with Eastern Queensland. The tropical vegetation of the latter area is due to its uniformly distributed rainfall, while the northern territory does not possess any areas of deep rich soil such as are found in Siam or China.

In discussing the communications between North and South-East Australia, he points out that the traffic consists at present of cattle-droving, and the natural line is from Katherine *viâ* Camooweal to Bourke, *i.e.* down the western edges of the eastern pastoral country. This he considers preferable to the proposed central railway route from Oodnadatta *viâ* Alice Springs. The immediate policy should be to evolve a north-south line by linking up the lines in Western Queensland as they develop to meet existing needs. The paper concludes with notes on the marginal regions, the results of personal observations. The best of these, where cattle and sheep are raised, are South Kimberley and Murchison in the west, and the eastern artesian regions of Barwon, Gregory, and Barkley. The "Desert outlet," between Broome and Marble Bar, is described as the most unattractive. The Nullabor region enjoys a reliable rainfall of 10 inches and good climate, but water cannot be conserved in the porous limestone.

It may be added to this note that bills have recently been introduced into the Provincial and Commonwealth legislatures providing for the extension of the railway from Oodnadatta to Alice Springs, as a definite step to a north-south line. A bill dividing the Northern Territory into North and Central Australia has also been introduced into the Commonwealth Parliament, the division to be the parallel of 20° S. Provision is also made for the development of North Australia by a Commission with headquarters at Newcastle Waters. The length of this section will be 279 miles. It is expected that the line will soon be carried further north to open up the mineral belt thought to exist in the Barrow Creek region. The Oodnadatta–Darwin motor route has recently become popular with tourists.

POLAR REGIONS

Eskimo Colony in East Greenland.

An interesting experiment is being made at founding a colony of Eskimo at Scoresby Sound in East Greenland (71½° N. lat.), for which purpose a committee was formed in Denmark a year or two ago. In the summer of 1924 an expedition to the spot was carried out in a vessel named the *Grønland* by the Danish Arctic explorer, Capt. Einar Mikkelsen, the object being to select a site for the colony and to make preparation for its settlement by the building of a house for the superintendent and others for the intended settlers. Capt. Mikkelsen gives an account of the voyage and the proceedings at Scoresby Sound in the *Geografisk Tidsskrift* for September 1925. Leaving Copenhagen on July 10 the *Grønland* reached Scoresby Sound early in August, the conditions in 1924 being particularly favourable for navigation: the ship was caught in the ice for a short time off Cape Tobin (the northern portal of the Sound) and the vessel was lifted 3 or 4 feet by the pressure, but escaped without damage. An excellent harbour was found in the north-east angle of Rozenvinges Bay, just within Cape Tobin, and examination proved it the most suitable site for the colony. It is nearly landlocked, with an entrance only a kilometre wide, and the water within was sufficiently deep to permit the vessel to be anchored only 6 to 8 metres from the shore, while the bottom was good holding ground. The harbour received the name Amdrup's harbour, and the point to the north of the entrance near which will be the headquarters of the colony Ferslews Point. Capt. Mikkelsen believes that access to this harbour will be possible each year, but in case it should not there is another harbour outside Cape Tobin where stores, etc., could be landed and carried overland to the colony. While the goods brought by the *Grønland* were being unloaded, Capt. Mikkelsen made a trip to the west in a motor boat, visiting Ryder's depôt near Cape Stewart, which he found had been wantonly ransacked by ships' crews and the building partly destroyed: it can however be repaired. An inspection of Hurry inlet showed no traces of the native settlement which some had thought might exist there. It is proposed to place the settlers at various spots within a certain radius from the headquarters, and the places selected are at Cape Stewart, Cape Hope, and Cape Tobin, at each of which there are the ruins of old native huts. The whole district appears rich in bird and animal life, extensive lists being given of the various species observed, and it is thought that the settlers will have no difficulty in obtaining a livelihood. The first party of colonists was taken to Scoresby Sound last summer.

OBITUARY

C. M. Doughty.

WITH the death of Charles Montagu Doughty, in January of this year, passed away, at the age of eighty-two, about the last of the illustrious Victorian explorers. His claim to be of that company was established so long ago as 1878, and not afterwards strengthened by further geographical work of importance, except in so far as this was involved in the preparation of the majestic narrative of his wanderings to which he devoted ten subsequent years, publishing it at last in 1888 at the Cambridge University Press under the now celebrated title 'Arabia Deserta.' The Royal Geographical Society, which had invited him to address it in 1883 (he proved unable, from "stage fright," to finish reading his paper to the evening meeting), lost, by declining Doughty's petition

for a grant in aid of publication, the chance of fostering a classic whose fame has steadily broadened to this day; and when it proposed, a quarter of a century later, to make amends by the award of a Gold Medal to the author, this was carried only after protest by one of those who had originally opposed that petition. It took, indeed, more than twenty-five years for the supreme merit of Doughty's matter and style to win general recognition; and the elder generation in particular remained awhile longer of the opinion to which one of Doughty's examiners at Cambridge, the late Dr. Bonney, had given practical expression in 1865 by awarding to the first-rate matter of the candidate's papers second-class marks because of their English style. The Royal Geographical Society, therefore, may plume itself on having been still somewhat in advance of the age in honouring its Medallist of 1912.

Charles Doughty, born of Suffolk county folk, had been intended for the navy, but was debarred from that service by a slight impediment of speech. He went eventually to Cambridge and studied geology. After graduating in 1865, he turned for some ten years to the study of the humanities and of languages at Oxford, Leiden, Copenhagen, and Louvain, and to roving, generally alone and afoot, somewhat after the manner of Borrow, all over Southern Europe and in Egypt, Palestine, and Sinai. Thus he came to Petra and thence to Maan, where, in an Arab coffee-house, he heard of carved rocks near Medain Salih and El-Ala, on the frontier of Hejaz. He was tempted to visit them, partly by archæological curiosity, partly by the natural affinity of his simple romantic disposition with wild Arab life, but most by a paramount desire to find matter and setting for a narrative which, by archaistic treatment of a primæval world, should "redeem English from the slough into which it had fallen since the days of Elizabeth." Back to Spenser was his principle. In later life, when his youthful interest in desert men had largely been eclipsed by concentration on poetry, and his enthusiasm for Spenserian diction had developed into almost fanatical obsession, he denied emphatically that he had gone into Arabia with any scientific aim whatever. But in his thirties his interests must have been wider, or he never would have collected with infinite pains and meticulous accuracy the mass of varied information on the physical relief, the geological composition, the hydrography, the antiquities, the tribal organization, and the social life of Arabia, which fills his two great volumes. Mr. Philby, having set himself after his own journey across the Peninsula seriously to study 'Arabia Deserta,' in 1918, was moved to say that everything about Arabia might be found in it, and that Doughty was always right. His geological chart of North-West Central Arabia stands alone to this day. He was the first to trace to their heads its two chief drainage systems, and Snouck Hurgronje has borne witness to the finality of his picture of Bedouin life. He took sufficient interest, at any rate, in his map to protest with naïve indignation against the "adjustments" to which it had to be subjected by the draughtsman. God, he wrote, put the mountains just there and there, and all the geographical societies in the world were powerless to alter them!

The course of his two years' solitary wandering, narrated in 'Arabia Deserta,' is too well known to call for repetition in detail. Doughty went up from Maan to Damascus, lived there awhile as Halil ("Friend"), being known then and always for a Christian, and succeeded in persuading the Kurdish Pasha, who was to lead the Pilgrim Caravan of 1876, to allow him to accompany it as far as the boundary of forbidden Hejaz, and to await its return at Medain Salih. Many experiences, and latterly one near Petra, had taught him that he could not hope to win through otherwise. Arrived at his goal, he passed some months

in a little room in the fort after the caravan had gone forward to Medina, and by one way and another came to form relations with Bedouins, and to see his way farther into the land. Accordingly, when the Pasha returned, he begged to be left where he was to try his luck. Presently he got away from the fort to the black booths of his friends, and so bit by bit came to Teima (where he discovered the famous stone now in the Louvre), Jebel Shammar, and Hail. The great Rashid Emir, Mohammed, who then reigned, furthered him to Kheibar, where, he had heard, survived relics of Jews of the Prophet's day. But such he found not, and met misfortune; for in Kheibar the Emir's writ ran less strongly than the Turk's. But Doughty's gentle simplicity made the oasis folk his friends, and in the end he got back to Hail, only to meet there, in the Emir's absence, with the cold reception that waits on the reappearance of one who had seemed a good riddance. Told to begone once more, he set off southward, and through danger and difficulty reached Kasim. Boreida would have none of him; but Aneiza, more mercantile and enlightened, made some amends, and at the last sent him on with its butter caravan by the long Mecca road, untravelled, to this day, by any other European explorer. As a confessed Nazarene he might not approach the Holy City, but must turn off one march short of it to seek the protection of the Sherif at Taif. On the way thither, riding on one camel with a fanatic, he came nearer to that end by violence with which many had threatened him during two years past; but he extricated himself and was civilly entreated by the politic Sherif and sent down to Jidda in the summer of 1878.

Arabs of the Hejaz borderland, says T. E. Lawrence, still remember "Halil" for his gentleness, his courtesy, and his truthfulness. His soft low speech, unexpected from a man of his commanding stature and mien, always commended him to them, and with his amateur skill as a *Hakim* he could render many services. Thus he came alive and comparatively unscathed through that long-drawn adventure as a solitary Nazarene (for by this term of contempt he allowed himself always to be called). It was a Quixotic enterprise, and the result, 'Arabia Deserta,' was of a piece with it. After ten years' unremitting endeavour to recall and, without thought of any concession to the weakness of readers, to represent his experience just as it had been from day to day, he offered to publishers a manuscript, couched in a blend of Spenserian English with fresh-minted Anglo-Arabisms, running to more than 600,000 words. But for the perspicacity of two Cambridge Professors, 'Arabia Deserta' might well have been unprinted at this day. Doughty spared his publisher no more than the public. A proof-sheet only incited him to recast the matter it contained to the greater honour of Truth and the Elizabethan Style. But the book did at last appear, at the then high rate of two guineas, to be welcomed as a classic by prophets, like William Morris, but for half a generation respectfully avoided by others. The edition had been numerically small, but well into the present century the book was still to be had new at its published price. About 1904 it began to appreciate. It was written about and quoted. An abridgment appeared in 1908. It figured prominently and constantly among *desiderata* in the catalogues of leading booksellers, and even before the war had attained the distinction of being auctioned as a lot apart. But it was the War itself that, bringing Arabia into the limelight, suddenly revealed to all sorts and conditions in this country and in the United States the greatest book ever written about it. Thanks chiefly to T. E. Lawrence, three reprints were issued subsequently in quick succession, and Doughty, to whom also the War had recalled Arabia, was moved in the evening of his days to

revive dormant memories of its blistered sands and black booths leaking to the rain of light.

Like his own Arabia, Doughty never seemed to belong to any century in particular. His primæval mind was of no date. He stood as alone in the latter-day world as the first Man stood in the Garden. Therefore, of all his poems, that which has Adam for hero best represents its author. D. G. H.

Sir Edward Ernest Pearson.

We regret to have to record the death, on November 19 last, of Sir Edward Pearson, who had been a Fellow of this Society since 1907. He was a brother of Viscount Cowdray, and was associated with him in the engineering firm of Pearson & Son. Among the works by them with which he was identified and in the execution of which he travelled extensively, was the building of the Malta dry dock and breakwater, and especially the port works at Valparaiso between 1913 and 1922. During the war he was in charge of the building of the great munition factory at Gretna Green, and was knighted for his services in 1917. Later he went out to France to report on the organization of labour. He was Chairman of Westminster Hospital for four years. Sir Edward married Grace, youngest daughter of R. B. Croft, of Funhams Hall, Ware, and leaves three sons and three daughters.

MEETINGS: ROYAL GEOGRAPHICAL SOCIETY: SESSION 1925–1926

Eighth Evening Meeting, 22 February 1926.—The President in the Chair.

ELECTIONS.—Reginald John Bee; Pandit Shri Dhar Lal Bhargava, M.R.A.S.; Colonel G. T. Brierley, C.M.G., D.S.O.; Robert Stopford Broadbent; Rev. John George Thomas Castle, M.A.; Mrs. Edith Chichester; Thomas William Clementson; Capt. George Matthew Coombs, B.A., B.SC.; Major Percival William Elliott, I.A.; Rev. William Davy Filliter, M.A.; George Cyril Griffith-Williams, M.A.; John Leonard Hathaway; Edward Ernest Doxford Hedley; Lieut.-Col. Arthur Pelham Heneage, D.S.O., M.P.; Fenley Hunter; Miss Irene Helen Lowe; Christopher Naisbitt; Henry Arthur Parsons; Thomas H. Pritchard; Miss Maud M. Rider, B.SC.; Jonathan Sargenson Sharp; Edgar Silvanus Shrimpton.

Paper: The Glaciers of Hunza. Mr. and Mrs. Visser.

Ninth Evening Meeting, 8 March 1926.—The President in the Chair.

ELECTIONS.—David Bowen; Frederick William Schofield Brabham, M.A.; Rev. David MacCulloch Brown, M.D.; John Cecil Burton; Lionel Milner Butterworth; Sir T. W. Edgeworth David, K.B.E., C.M.G., D.S.O., D.SC., F.R.S.; Arthur William Dye; Henry William Edwards; Charles H. Fahs, B.A., B.D.; Lt.-Col. Frederick Durand Stirling Fayrer, I.M.S.; Horace Fleming, J.P.; Alvary Gascoigne; Mrs. A. D. Gordon; Bernard Vincent Grealy, M.S.E., M.I.STRUCT.E.; A. B. B. Howell, M.B.E.; Edward Sylvester Hynes; Mirza Ali Ispahani, B.COM.; Mrs. Myles Kennedy; Herbert Wesley Lawton, B.A., F.R.H.S.; Prof. Joseph Brown Matthews, M.A., B.D., S.T.M.; Nanayakkarnpathirage Solomon Perera; Donald Ellis Willington.

Paper: The Geography of the Mosul Boundary. Major H. I. Lloyd.

Fifth Afternoon Meeting, 15 March 1926.—The President in the Chair.

Paper: The Surveys of Canada. Col. H. S. L. Winterbotham.